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SOME MACHINERY AND METHODS OF WATCHMAKING

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IN going through a large watch factory there are many processes to be seen that only a skilled watchmaker could thoroughly understand and appreciate. There are, however, many things that are of intense interest to the average mechanic and which are well worth the time required to see them, but as few mechanics have either the time or opportunity to do so, the writer will proceed to describe some of the things that impressed him the most while going through the big plant of the Illinois Watch Company at Springfield, Ill. Through the kindness of President Bunn and Superintendent Johnson, the following illustrated article is given:

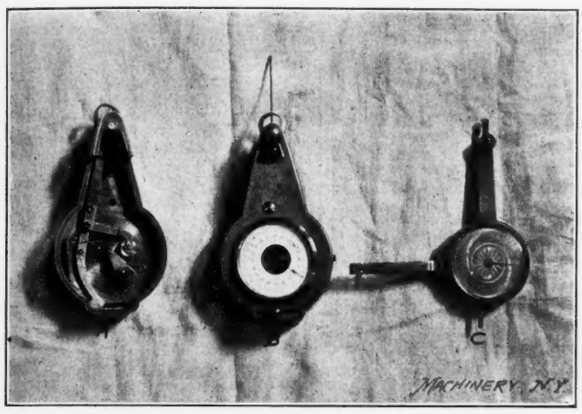

Fig. 1. Caliper Gage and Test Indicator used in Watchmaking, Illinois Watch Company

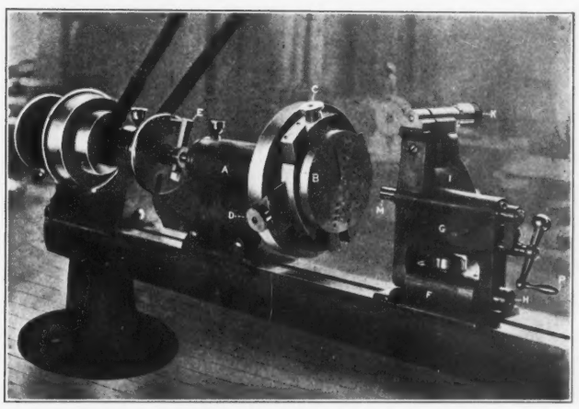

Fig. 2. Dividing Head and Tool Rest used in Laying Out and Boring Master Plates

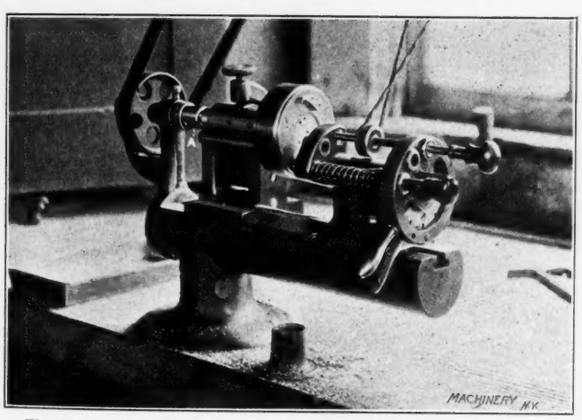

Fig. 3. Bench Lathe equipped with Quill used when Boring Center Holes in Watch Plates

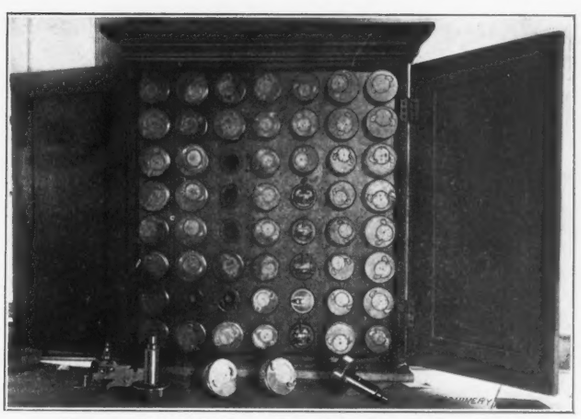

Fig. 4. A Set of Quills used for Boring the Various Holes in Watch Plates

The toolmaking work, as that term is usually understood, is, in this factory, separated into two classes and done in different departments, each in direct charge of a competent foreman of long experience. These departments are known as the machine shop, in charge of G. W. Meredith, and the punch and die department, in charge of C. H. Dockson. There is also a subdivision of the machine shop, known as the cutter making department, in charge of A. R. Mills, under the supervision of Mr. Meredith. In the machine shop proper all of the special machines, jigs, fixtures, master-plates and tools are made that are not included in the work of the punch and die or cutter-making shops. The bulk of the general machine repair work is also done in this department. The punch and die department not only includes the making of punches, dies and sub-presses, but it also includes the actual punch press work, and, consequently, in addition to its special toolroom, it has a complete battery of punch-presses in constant operation. The cutter-making department attends to the making and grinding of all mills, saws, counterbores and tools of that character used in the factory.

All of the fine caliper gages of the type shown at *A* and *B*, Fig. 1, and in detail in Fig. 5, are made in the machine shop. These gages are used in various forms throughout the factory for all the fine measuring required in turning out accurate work in quantities. At *C* this gage is shown in a modified form used for center indicating. Similar fine caliper gages are made and used in other watch factories to some extent. As will be seen from the engravings, the hand of the dial is operated by a small watch-chain or fusee-chain as it is sometimes called, which is wound around the spindle to which the hand is fastened. This spindle has a watch spring coiled around the lower end in such a way as to pull the indicator hand toward zero and keep the chain wound up as far as the caliper jaws will permit.

For laying out, drilling, and boring master plates, the special dividing-head and swing tool-carriage shown in Fig. 2 are used. The dividing head *A* consists of a false face-plate *B*, which is fastened to a cross-slide and which, in turn, is attached at right angles to another cross-slide, the guides of which are solid with the face-plate proper. The whole mechanism is mounted in a bearing of its own and is driven by means of the dog *E*, which engages a slot in the lathe face-plate, as shown. The plate *B* is graduated on its periphery in degrees, and it can be easily turned on its center and clamped at any desired angle. The cross-slides are both fitted with micrometer screws which afford quick and accurate adjust-

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ments of the plate in either direction along their line of travel. As can be easily seen, the tool carriage *F* has a part *G* which is hinged at *H* and which may be adjusted out or in by means of the micrometer head *K*, mounted in part *I*, which is solid with the base of the carriage. The center of the tool-holder or spindle *M* in which the boring tool is placed, is exactly half way between the center of the pin *H* and the center of the micrometer head *K*, so that if the micrometer screw is turned outward 0.001 inch the tool is set out just half as much, or 0.0005; in other words, the direct reading of the micrometer indicates the amount that the bored hole will be enlarged on the next cut. The tool is fed into and out of the work by turning the handle *P*.

Formerly all master plates were originally plotted out as shown in Fig. 6, all holes to be bored being figured in two directions from a central point as shown, but the method illustrated in Fig. 7 is now considered much simpler to work from and less liable to error for this class of work. In this plan all holes that are the same distance from the center point are connected by arcs and their distances from a center line marked zero are indicated in degrees. The advantage of this last method to the toolmaker will be at once apparent to anyone who has ever worked out a complicated plate by the first one.

The mounting of the dividing head of the machine shown in Fig. 2, in its own bearing, illustrates the general principle

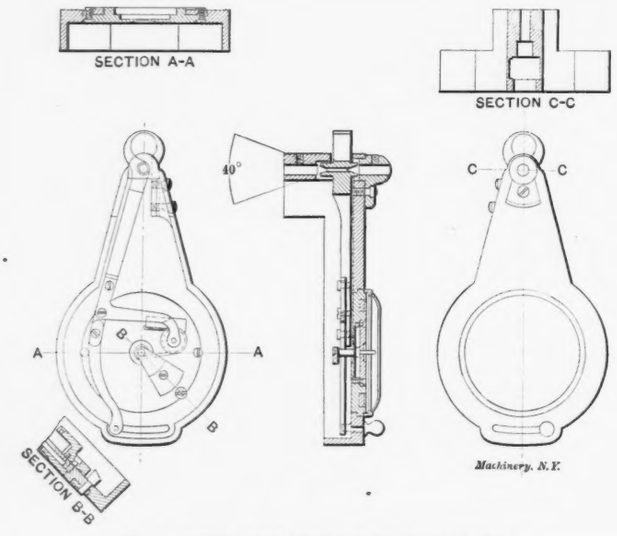

Fig. 5. Detail of the Caliper Gage shown in Fig. 1

upon which all fixtures used in the factory to hold parts to be bored are made. The usual form of individual bearing, or quill as it is called when used with a separate holder, is shown in Fig. 3. The quill illustrated in this engraving is used to hold a watch-plate while the center hole is bored. The quill holder is in the form of a V-block and clamp, and the quill is

10 Size Master Plate No. 1. Refer to Fig. 6

1. Hunting Barrel.
1. Open Face Barrel.
2. Center and Curve Center No. 3 Barrel Bridge.
3. Third and Curve Center No. 3 Train Bridge Three-quarter Plate and Barrel Bridge No. 4.
4. Fourth.
5. Escape.
6. Pallet.
7. Balance and Curve Center No. 5 Train Bridge Three-quarter Plate and Barrel Bridge No. 2.
8. Dial Foot.
9. Dial Foot.
10. Dial Foot.
11. Curve Center No. 1 Train Bridge Three-quarter Plate and Barrel Bridge No. 5 Three-quarter Plate.
12. Curve Center No. 2 Train Bridge Three-quarter Plate.
13. Curve Center No. 4 Train Bridge Three-quarter Plate.
14. Curve Center No. 6 Train Bridge Three-quarter Plate.
15. Curve Center No. 1 Barrel Bridge and No. 1 Balance Cock, Bridge and Three-quarter Plate.
16. Curve Center No. 3 Balance Cock Bridge and Three-quarter Plate.
19. Train Bridge Screw No. 1. Three-quarter Plate.
21. Balance Cock Screw No. 1.
22. Curve Center No. 1 Cock No. 1 of Bridge, and No. 5 Barrel Bridge, Bridge Watch.
23. Minute Wheel Turning.
24. Curve Center No. 2 Cock No. 1 of Bridge and No. 1 Cock No. 2 of Bridge.
25. Curve Center No. 2 Cock No. 2 of Bridge and No. 1 Cock No. 3 of Bridge.
26. Curve Center No. 2 Cock No. 3 of Bridge.
31. Case Screw No. 1.
32. Case Screw No. 2.
36. Steady Pin No. 2 Train Bridge Three-quarter Plate.

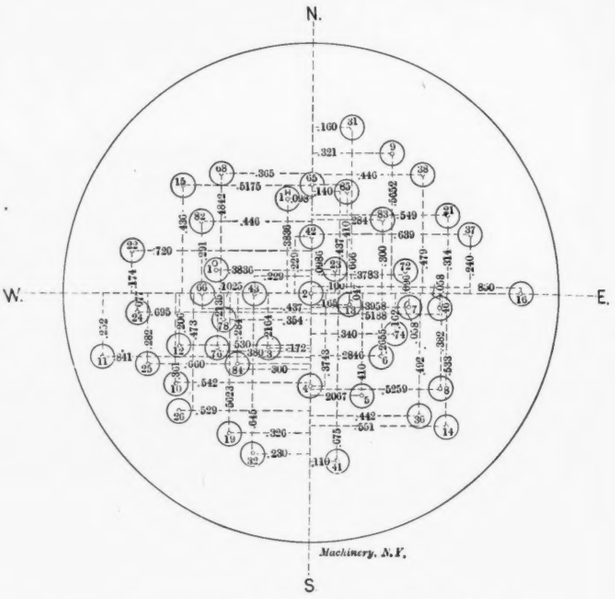

Fig. 6. Old Method of Laying Out Master Plates

37. Steady Pin No. 1 Cock.
38. Steady Pin No. 2 Cock.
41. Steady Pin No. 2 Train Bridge, Bridge Watch.
42. Setting Wheel, Open Face.
43. Setting Wheel, Hunting.
46. Hairspring Stud.
65. Winding Wheel Open Face.
66. Winding Wheel Hunting.
68. Click Screw.
72. Pallet Bridge Steady Pin No. 1.
74. Pallet Bridge Curve Nos. 2 and 4.
76. Winding Arbor Lever Screw, Hunting.

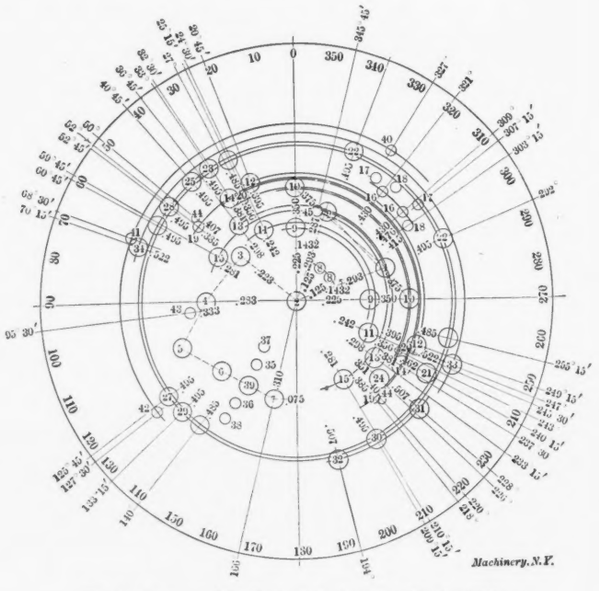

Fig. 7. Improved Method of Laying Out Master Plates

78. Crown Setting Pinion Stop Screw, No. 2. Hunting.
82. Click Pin Hunting.
83. Winding Arbor Lever Spring Turning, Open Face.
84. Winding Arbor Lever Spring Turning, Hunting.
85. Winding Arbor Lever Milling, Curve No. 1, Open Face.

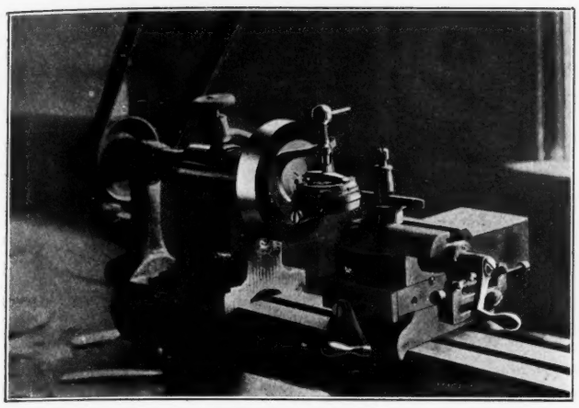

Fig. 8. Bench Lathe with Quill for Holding Works while Uprighting the Stem Holes

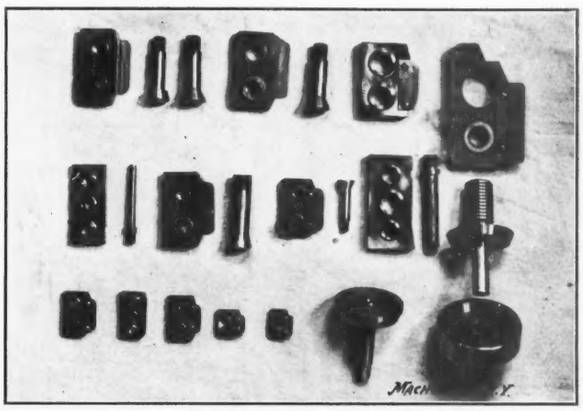

Fig. 9. Spring Chucks and the Templets used in Making them

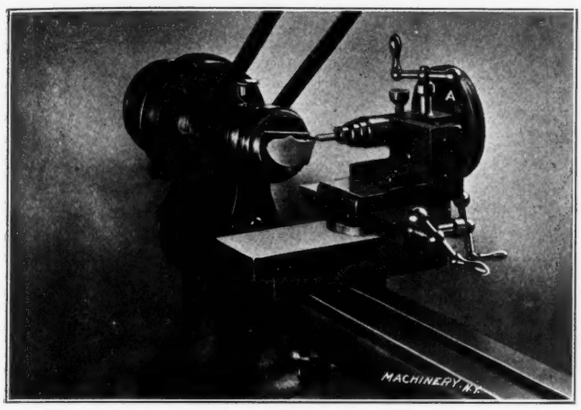

Fig. 10. Milling Attachment for Bench Lathe used for Milling Punches, Dies, etc.

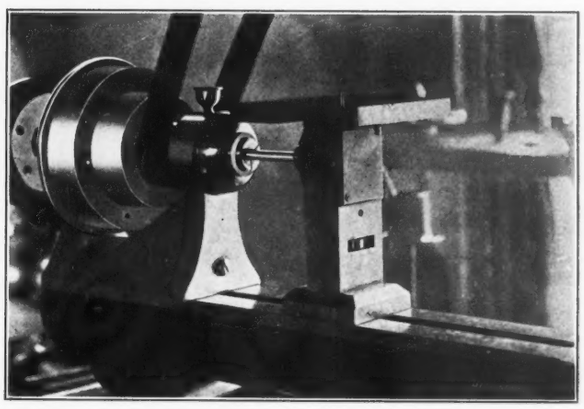

Fig. 11. Vertical Milling Attachment for Machining the Stripper Plates

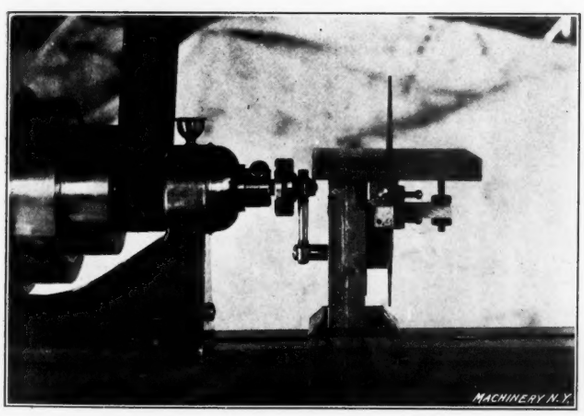

Fig. 12. Bench Lathe Filing Attachment for Filing Clearance in the Dies, etc.

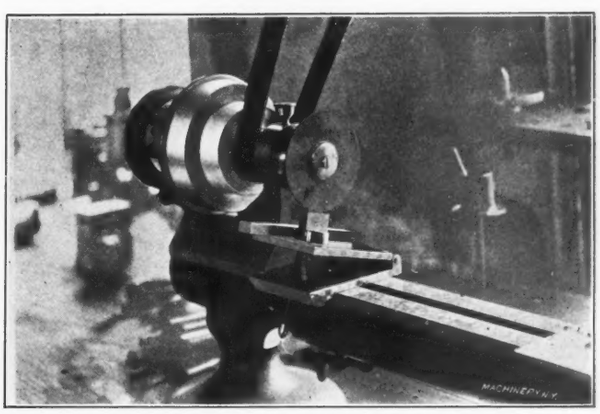

Fig. 13. Adjustable Plate for Surface Grinding on the Bench Lathe

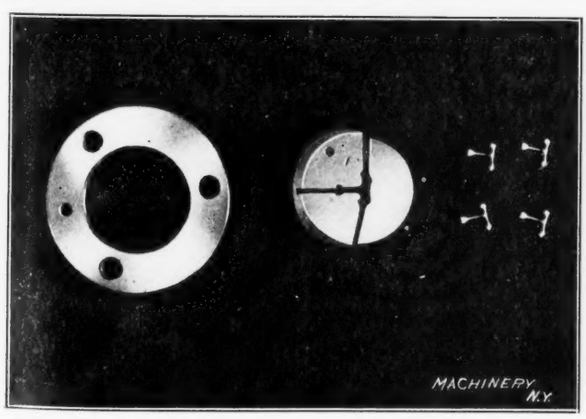

Fig. 14. Sectional Dies with Clamping Ring and Samples of the Work

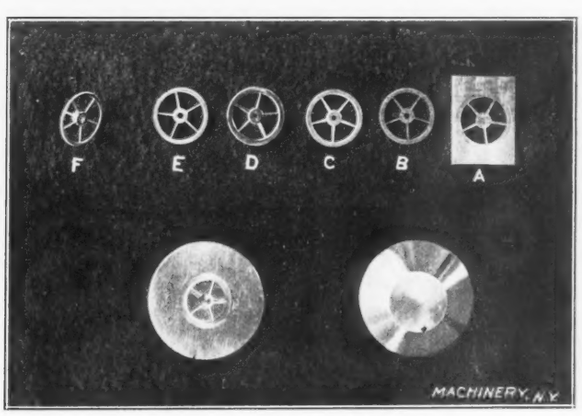

Fig. 15. Swaging Die and its Work

driven from the lathe spindle by a tongue and fork, as shown at *A*. Each train hole in a watch-plate has a separate quill for centering it while it is being bored out, the plate being located in the jig which holds it, by means of the dial feet holes. There are pins in the face of each quill so located that when they enter the previously drilled dial feet holes, the plate to be drilled is brought into the proper position.

The watch-plates are all first spotted for the drills, then drilled and finally bored as just mentioned. A number of these special quills are shown in Fig. 4, and also in Fig. 29, together with a few split chucks and another form of the fine gages used. Fig. 8 shows another quill fixture which is used in the factory for holding the watch works while uprighting the stem hole.

In Fig. 9 are shown a number of spring chucks and the gages used when making them. These gages or templets

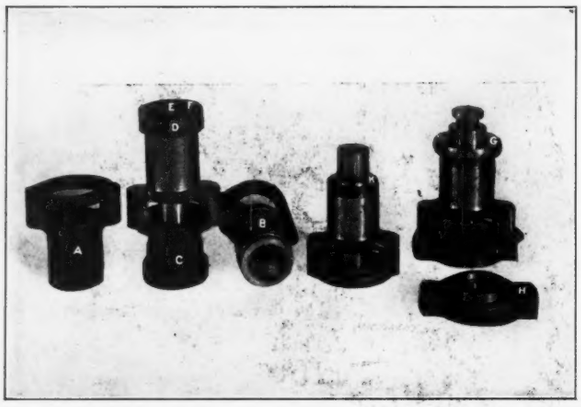

Fig. 16. Finished Sub-press, Component Parts, and Babbitting Jig

have threaded collars in them for the size and length of the thread, bored out collars for sizing the barrel of the chuck and pieces fastened to the side to give the length and also to hold the chuck in place while gaging the bevel.

Fig. 10 shows a milling attachment used on a bench lathe for working out slots and irregular places in small jigs, punches and the like. When using this milling attachment the lathe spindle is locked and the spindle of the attachment

Fig. 17. Thirty-three Thousand Steel Yokes Blanked Out in a Sub-press in Eight Hours

is driven by a round belt passing over pulley *A*. Several very interesting attachments for the bench lathe are to be found in the punch and die department, which have been made for the special work done there. Fig. 11 shows a table with a small end mill *A* in the center, which is used for some classes of die work. The milling cutter is rotated by means of a pair of bevel gears and a shaft connected to the lathe spindle. Fig. 12 shows a filing machine, the table of which can be tilted to a limited extent for the purpose of filing clearance in a hole or for other reasons. The stroke of the file is adjusted by shifting the crank-pin in the slotted plate which is attached to the nose of the lathe spindle. Fig. 13 shows an adjustable plate used when surfacing off small punches or dies with an emery wheel; this plate is extremely handy for many other light grinding jobs.

A grinder used for a number of special jobs is shown in Fig. 30. This machine has a revolving work holder with three heads. At *A* is a head consisting of a long V-block and clamp for holding punches or other round parts while squaring the ends. The engraving shows a sub-press piston being

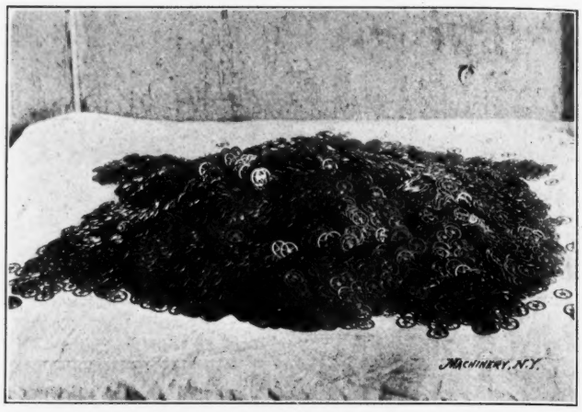

Fig. 18. Thirty-five Thousand Brass Center Wheels representing the Work of an Eight-hour Day

squared up. At *B* is a face-plate used for holding flat work; the third head is not visible.

Many of the dies made are for such small parts that it would be impossible to make them in one piece and work out the holes, so they are made in sections to facilitate their construction, as shown in Fig. 14. The outside edges of the die parts are slightly beveled and the clamping ring is

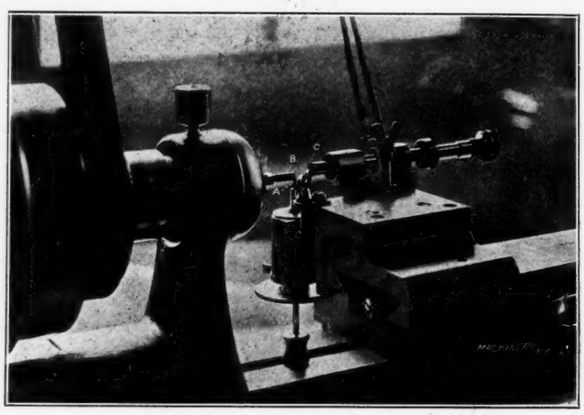

Fig. 19. Milling a Small Counter-bore in a Bench Lathe

bored to correspond, so that when the ring is pressed down the die parts are clamped closely and firmly together. Dowel pins in both the die and the ring insure their being replaced correctly if it is necessary to remove them from the sub-press for any reason. A die of this kind is always so divided that a possible fin or ridge on the punching would come at a place where it could be easily removed. Formerly many of the

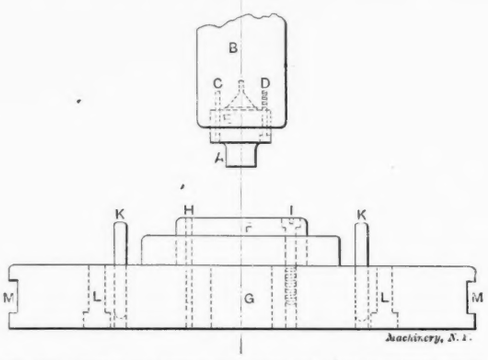

Fig. 20. Method of Fitting Punches and Dies in a Sub-press

punchings were polished on the edges by hand with diamond dust, but all of this class of work is now run through a series of special burnishing dies, the parts coming out with their edges as smooth and bright as a mirror. Fig. 15 is a swaging

punch and die used for rounding the spokes on some of the brass wheels. *A* shows the wheel after the first punching operation and still in the strip from which it was cut, and *B* shows it with the center hole punched. At *C* it is shown just as it comes from the swaging die for the first time. It is next annealed and again placed in the same die coming out as at *D*. The fin or flash is next taken off in a trimming die as at

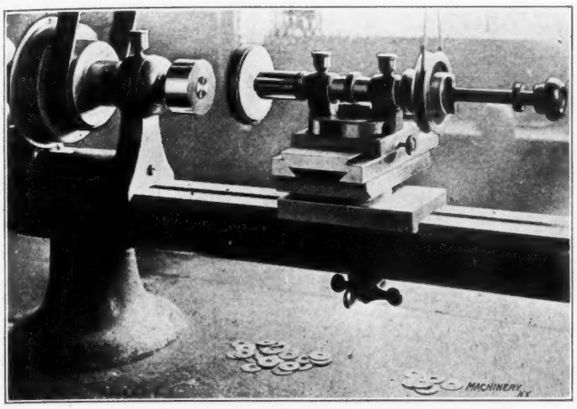

Fig. 21. Grinding the Sides of a Small Saw

E. A completely finished wheel, after it has gone through all the various processes and is ready for the watch, is shown at *F*.

The usual method of adjusting the stroke of the ram of a punch-press proved so unsatisfactory that all the presses in this factory have been fitted with a worm gear and worm adjustment, as shown in Fig. 31, in place of the regular gear and pinion-key form. In this way it is impossible for the ram to drop and spoil a die if the key happens to slip while adjusting, as it could originally; besides a more delicate adjustment can be easily made. This method of adjusting is,

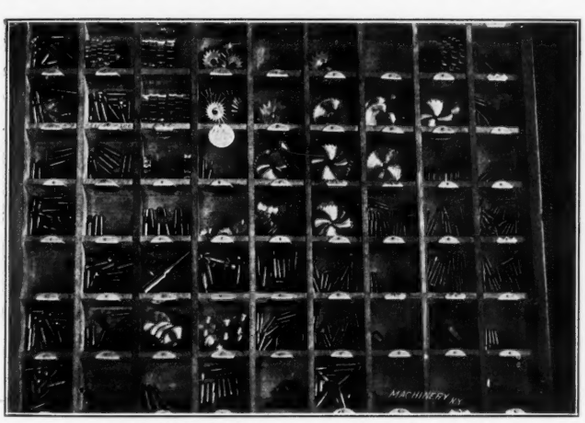

Fig. 22. Drawer Filled with Miscellaneous Tools used in Watch Construction

of course, old and presses could be bought years ago fitted in this way, but where presses of the other style are in use they can often be changed over to advantage as in this case.

Making Sub-presses of the Piston Type

As the punchings turned out in this factory are all small, the largest being one ounce in weight and the smallest running 16,000 to the ounce, it is obvious that the separate punch and die system cannot be used, so all punches and dies are mounted in sub-presses of the piston type, of which there are over 800 in use. The making of a sub-press as carried through in Mr. Dockson's department, is quite an interesting process from start to finish. The casting for the upper part or body of the sub-press is first put in a lathe with the rough barrel in the chuck, the bottom faced off and the bottom or base hole bored out, as shown at *A*, Fig. 16. The body is next strapped, barrel outward, onto a face-plate, and centered by a plug which is usually a piece of brass driven into the center hole of the lathe spindle, and then turned to fit the base hole in the casting. The barrel is now turned on the outside and bored taper inside, the outer end or top being the largest. Three or four (usually three) grooves are next cut in the bore as shown at *B*; the piece is then removed from the face-plate when it is ready for the next operation, which is casting the babbitt. In performing this operation, the sub-press body is placed on the special base *C*, which just fits the bored hole in the bottom of the body. The piston *E* is then slipped into place, and is held central with the bore of the barrel by holes in the center of the special base *C* and in the cap *D*, which is next put on. It should be stated here that in actual use the special base *C* fits up into the body so that its top covers the bottom of the bored barrel in order to keep the melted babbitt where it is wanted, the base and body being held tightly together during the casting process, by two C-clamps. In taking the picture, the body was purposely set up as shown in order to give a better view of the positions of the piston and the way it is held. The piston *E* has been previously ground perfectly true from end to end and has had three grooves cut in it lengthwise. It is also well smoked before it is put into the casting jig. The babbitt, which is

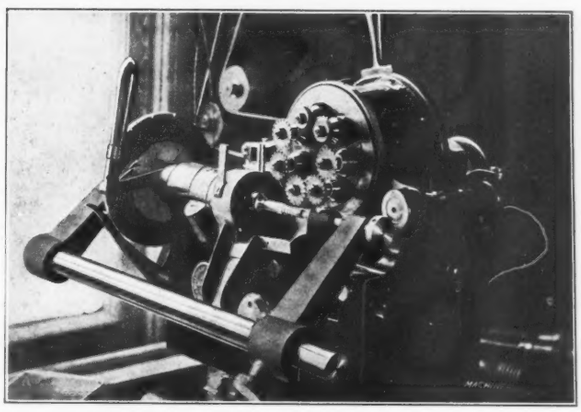

Fig. 23. Machine for Milling Steel Escape Wheels

made up of tin, antimony and a large percentage of copper, is now poured around the piston through the opening *F* in the cap *D*. Just as soon as possible, the whole thing is cooled off in water—the sooner the better. The piston is now pressed out—and this is one of the hardest jobs of the series, for it takes a husky man at each end of an 8-foot lever on a powerful screw press, to start it. After being removed, the piston is carefully lapped with a copper ring-lap and emery, and the grooves are also lapped until the piston can be worked in and out of the barrel with some degree of ease. A collar like the one shown at *G* is next fitted on so as to hold the babbitt firmly in place, for while the taper bore of the barrel prevents the babbitt from going down, it does not keep it from being pulled

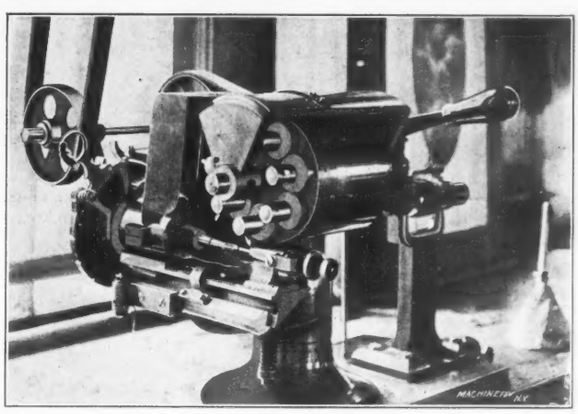

Fig. 24. Machine for Milling Brass Escape Wheels

up. The body and piston are then put into a punch-press and "pumped" at a good rate of speed for some time in order to wear them in, the "spots" on the babbitt being carefully scraped from time to time. When worn in a sufficient amount, the piston is removed and carefully re-centered in a lathe, a bored ring being used to hold it. The piston is again replaced in the barrel, put between centers, and the bottom and bored hole of the body carefully trued up. In this way any untruth that may have crept in is corrected and the outside of the

piston, its centers and the bore of the bottom of the body are made absolutely concentric. The base *H* of the sub-press is next fitted, doweled and fastened to the body by two fillister head screws. The bottom of the base is then trued up by taking a light cut over it, using the piston as a mandrel.

The idea of making the bore of the barrel of the sub-press taper, is not simply to keep the babbitt from dropping down, as a shoulder would answer for that; but the main reason is that if the piston becomes loose from wear at any time, the babbitt, which has been left high on top, as shown at *K*, can be forced downward by using a ring and a powerful press, thus taking up the wear. The retaining ring on the top of the barrel is not powerful enough to do this, as it is only intended to keep the babbitt from coming out, as stated.

The way the punches and dies are set into the sub-presses is shown in Fig. 20. In making the piston *B* a recess is bored in the end into which the punch *A* is fitted and fastened by a dowel-pin and screws. The center *E* of the piston is set in far enough so that the punch will not mar or distort it, should it be desired to put the piston between centers. In the lower part of the engraving, *F* is the die, *G* the sub-press base, *H* a dowel in the die, *I* one of the screws used to hold the die in place, *K* dowels that locate the body onto the base, *L* holes for the screws which hold the body and base together, and *M* recesses for the ends of the straps used to strap the sub-press to the bed-plate of the punch press.

Fig. 25. Screw-head Polishing Machine

Fig. 26. Machine for Damaskeening the Works

As a general rule, in fitting a punch and die into a sub-press, the master punch is fitted into the piston as explained, and a die blank, the top of which is tinned with solder, is fitted into the base. The punch is then brought down and an impression of the outline made in the solder. The die blank is then removed and drilled out as close to the lines of the impression as it is safe to do, after which the die is slowly and carefully worked out and finished with the master punch as a guide.

Sub-presses of the type just described can be set up in a punch-press in a very short time, and the speed at which work is run through them is marvelous. In Fig. 17 is shown a pile of 33,000, number 18 size steel yokes, which were blanked out in 8 hours, and in Fig. 18 is a pile of 35,000 brass center wheels which were also cut in an 8-hour day. Some of the parts are blanked out at an average speed of over 120 a minute. As a rule it is intended to keep about 65,000 wheels of each kind in stock, ahead of the factory demand.

In the cutter making department the various tools are made in much the same way as in other tool rooms, only the machines used are much smaller. Fig. 19 shows how a small counterbore is milled. The blank, which has been turned up in a lathe, is placed in the upright chuck, as shown at *A*. The flat is milled on one side with the mill *B*, the blank is indexed half a turn and the other flat milled. Cutter *C*, which has teeth on the end only, is then used to mill the clearance on the cutting edges. Small saws are held on an expanding stub mandrel and ground by feeding a cup wheel, set at a slight angle to give clearance, straight in against them, as shown in Fig. 21. Fig. 22 is a drawer full of cutters of all kinds made in this department.

Outside of the toolmaking departments the factory has many interesting tools and devices, only a few of which can find space in this article.

Fig. 23 shows the machine used for cutting the teeth in steel escape wheels, seven cutters being used on each tooth,

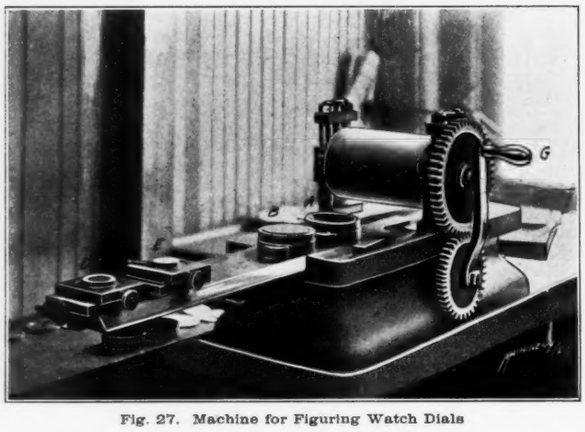

Fig. 27. Machine for Figuring Watch Dials

Fig. 28. Case in which Finished Watch Parts are Stored

and Fig. 24 is the machine used on brass escape wheels, fly cutters being used instead of milling cutters as in the previous machine.

Small screw heads are polished by placing the threaded end in the split chucks of the machine shown in Fig. 25 and then holding a fine stone against the revolving head of the screw. The fancy spotting or birdeye ornamenting of the watch plates is done with the machine shown in Fig. 26.

Fig. 32 shows the profiling machine used for cutting out the irregular recesses in the watch plates.

Minute pinions are fastened to their staffs with the little trip hammer shown in Fig. 33, which rivets over a cup-shaped part of the staff onto the pinion.

A Transferring Machine

The figures and graduations are put on the enameled watch dials in the machine shown, in Fig. 27. *A* and *E* are steel plates into which the figures and graduations have been cut;

B and *D* are dial holders and *C* is a rubber roll. Special "paint" is smeared over plates *A* and *E* and then scraped off with a thin steel knife, leaving the engraved places full. Dials are now placed at *B* and *D* and the handle *G* is turned so as to run the table under the roller. As *A* and *E* pass under, paint is left on the rubber from which it is transferred to the dials. For putting special names on dials, the press shown in Fig. 34 is used, though the process is very similar. *A* is the engraved plate, *B* the dial, and *C* a rubber pad. In using this press *A* is painted as before, swung under the rubber pad, and the pad brought down on it, receiving the lettering. It is then lifted, the dial swung under and the paint transferred to it.

All small finished watch parts are stored in glass stoppered bottles arranged in cases, as shown in Fig. 28, and in this way they are kept free from moisture and at the same time are easily accessible.

* * *

A convenient rule-of-thumb for ascertaining approximately the size of engine required to drive a direct-current dynamo is given in *Power*. To find the brake horse-power required, multiply the kilowatts of output by 1.7 for small machines, 1.6 for medium sizes, and 1.5 for dynamos of 500 kilowatts and over.

Fig. 29 Case of Watch Plate Boring Quills, Split Chucks, and Fine Caliper Gages

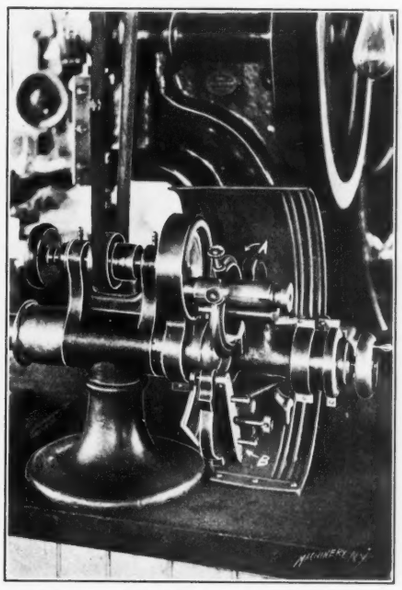

Fig. 30. Special Three-head Punch and Die Grinding Machine

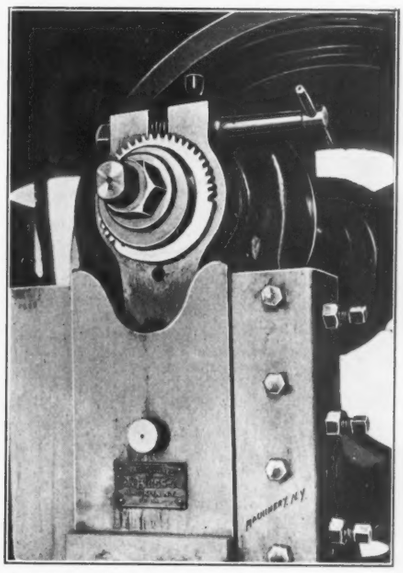

Fig. 31. Punch Press with Worm Gear Adjustment

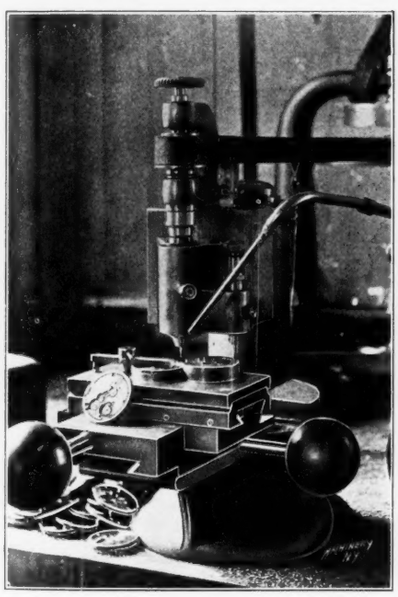

Fig. 32. Profiling Machine used for Recessing Watch Plates

Fig. 33. Miniature Trip Hammer used for Fastening Minute Pinions to their Staffs

Fig. 34. Press used for Stamping Special Names on the Dials

SOME THOUGHTS ON MACHINE TOOL DESIGN*

FORREST E. CARDULLO†

There is probably no branch of machine design in which greater changes have taken place in recent years than that of the design of machine tools. The greater part of these changes are without doubt due to the work of Mr. Fred W. Taylor, the discoverer of high-speed steel, who has more thoroughly investigated the capabilities and possible performances of metal cutting tools than any other man the world has ever known. The writer had occasion some time ago to study carefully Mr. Taylor's paper "On the Art of Cutting Metals" in the course of his lecture work on machine tool design at Syracuse University. His study of this paper, together with his own experience in machine tool design and operation, has brought the writer to certain conclusions in regard to some points in machine tool design which will be

* For previous articles on machine tool design and kindred subjects see: Designing of Machine Frames, August, 1908; Simplicity of Machine Tool Design, August, 1908; Tumbler Gear Design, December, 1907; Faults of Iron Castings, October, 1907, and November, 1907; Unit System of Machine Tool Design, November, 1907; Feeds and Feed Mechanisms, August, 1907; Design of Bearings, December, 1906, and January, 1907, and February, 1907; Choice of a Factor of Safety for a Machine Member, January, 1906; Machine Tool Drives, October, 1906.

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of interest and value not only to those who may themselves design and build such tools, but also to everyone who has to purchase or use them.

Ratio of Speed Changes

The first point to which the writer would call attention is the necessity of a sufficient number of speed changes. Those who have read Mr. Taylor's paper will remember that he shows that there is a definite relation between the cutting speed and the length of time which a tool will last without regrinding. Should the machine be run at too high a speed, the tool will last but a short time before it will have to be reground. Should it be run at too low a speed, less work, of course, will be done, although the tool will last a comparatively long time. Somewhere there is a golden mean at which the cost of machining plus the cost of tool dressing is a minimum, and theoretically our machine should always be run at that speed. Or course, in handling materials of varying grades of hardness, and, in the case of lathes and boring mills, of varying diameters, this would necessitate a very great number of speed changes. If the number of speed changes be limited, it is apparent that the machine cannot always be working at the point of maximum efficiency. The speed of cutting which gives the maximum efficiency is shown in Mr. Taylor's paper to be that speed which will destroy the tool in from 50 minutes in the case of ⅝-inch × 1-inch roughing tool, to 1 hour and 50 minutes in the case of a 2-inch × 3-inch roughing tool. These times are of course only approximations and will vary somewhat with the cost of steel and labor and the value of the machine in which the tool is used. If the machine be slowed down from this proper speed, the cost of machining will slowly increase, but if the machine be speeded up above this proper speed, the cost of machining will increase very rapidly. In his paper Mr. Taylor gives a diagram wherein it is shown that if the machine be slowed down so that the duration of the cut is increased from 50 minutes to about 4 hours and 40 minutes, the machine is then working at about 90 per cent of its former efficiency. If the machine be speeded up until the duration of the cut is decreased to about 15 minutes, the machine will again be working at about 90 per cent efficiency. This range of speed is shown by Mr. Taylor's equations to be in the ratio of $\sqrt[8]{15}$ to $\sqrt[8]{280}$ or of 1 to 1.45. Consequently, if we have a machine having several speeds with the constant ratio of 1.45 between the successive speeds, we know that such a machine may always be made to operate within 90 per cent of its maximum efficiency, and that on the average it will operate at more than 95 per cent of its best efficiency.

The following table, which is derived in the manner indicated from the diagram given in Mr. Taylor's paper, shows the speed ratios corresponding to the given average and minimum efficiencies of working:

Ratio	Average Efficiency	Minimum Efficiency
1.1	99.6 + per cent	99.2 per cent
1.2	98.7 + per cent	97.3 per cent
1.3	97.3 + per cent	94.5 per cent
1.4	95.6 + per cent	91.2 per cent
1.5	93.5 + per cent	87.0 per cent
1.6	90.6 + per cent	81.2 per cent
1.7	86.5 + per cent	73.0 per cent

From the table it will appear that even in the case of very costly machines it is of no particular advantage to reduce the ratio between successive speeds unduly. For instance, by doubling the number of speeds and reducing the speed ratio from 1.2 to 1.1, we will increase the average efficiency of the machine only about 1 per cent. It is very doubtful if the accidental variations in shop conditions would not be so great that the gain in practical work would be nothing, since the workman or the speed boss, as the case might be, would be unable to decide which of two or three speeds would be the best. The writer is therefore of the opinion that there is absolutely no practical advantage in reducing the speed ratio below 1.2 and that in the case of machines of ordinary type and cost, a ratio of 1.3 is as small as is advisable. In the case of a speed ratio of 1.3, the machine can always be made to operate at such a speed that the efficiency of working will be above 94.5 per cent and in the average case the efficiency will exceed 97.5 per cent. The 2.5 per cent loss of efficiency so caused is inappreciable as compared with other sources of loss, and it is exceedingly doubtful if the added cost of additional speed changes would not more than compensate for the possible 1 or 2 per cent of gain, entirely aside from the question of whether the extra speed changes would permit this theoretical gain to be realized.

The writer is also of the opinion that a speed ratio of more than 1.5 in the case of expensive machinery operated by highly skilled help, or of 1.7 in the case of cheap machinery operated by comparatively unskilled help is unadvisable. It will be seen that with a speed ratio of 1.5 the average efficiency of working is somewhat greater than 93.5 per cent, making the loss of efficiency in the average case about 6 per cent. It will be seen that when the rent of the tool plus the wages of a mechanic amounts to $4 a day or upward, this 6 per cent of loss means a money loss of $0.25 or more per day, or upward of $75 a year. Of course an increase in the number of speed changes and reduction of ratio would not save all this loss, but assuming that it would save half of it, and further, that the machine is operating only half the time, it is evident that we can afford to spend $150 or $200 for the extra speed changes necessary in order to bring the speed ratio down to 1.3. In the case of ratio of 1.7, the loss is 12 or 13 per cent instead of only 6 per cent, and these figures apply with greatly added force.

We are thus compelled to the conclusion that the useful range of the speed ratio in machine tool work is very narrow, ranging from 1.3 to 1.5 in ordinary cases and that a range of from 1.2 to 1.7 includes the very extremes of rational practice.

Need of Speed Changes being Easily Made

A second point in connection with the matter of the speed changes of machine tools which is of great importance is that these changes should be easily and quickly made so that the operative will have every incentive to use the proper speed. This is a matter of less importance in the case of planers than in the case of lathes and boring mills, since a planer requires a change of speed only when the character of the material which is being cut is changed, while the lathe requires a change when any great change is made in the diameter of the work operated upon.

In this respect a motor-driven tool may have a distinct advantage over a belt-driven tool. The controller furnishes a ready means for varying the speed while the shifting of a belt from pulley to pulley is not always readily accomplished, and most machinists would much rather take two cuts of differing diameters on the back-gear than shift the belt from the small to tne large pulley and throw out the back-gear in order to obtain the faster speed from the open belt. This is particularly the case when the cuts are of small duration, so that the shifting would be frequent.

It will be evident to the thoughtful mechanic that it is of great advantage to have the speed-changing mechanism so constructed that the change may be made without stopping the machine. In the case of large machines it will be of great advantage to be able to effect the speed change from the operating station, which for instance in the case of a long lathe will be the carriage. To the writer's mind the particular advantage of these refinements which he suggests, and which will be found embodied in many of the designs of our best tool makers, lies not in the fact that the time required to make the necessary speed changes is shortened, but in the fact that the workman finds it just as easy to run his machine at the proper speed as at an improper one.

Ratio of Feed Changes

A matter of even greater importance than a proper series of easily-made speed changes is a proper series of easily-made feed changes. A change of speed does not mean in general a correspondingly great change in the efficiency of operation of a machine tool, but a change in feed does. Mr. Taylor points out in his paper that in general the best results in quantity of metal removed per hour are obtained when the cross section of the chip is a maximum, even though this entails a comparatively low speed. Therefore it is of importance that the machinist be able to take the heaviest cut which the nature of his work and the power and stiffness of his machine will permit. Just as the best results in the

matter of cutting speeds are obtained when the successive speeds run in geometric ratio, so the best results in the matter of feed adjustment are obtained when the successive feeds run in geometric ratio, unless the number of obtainable feeds is so great that the entire range is closely covered. For instance, a lathe equipped with the following feeds, 0.05, 0.10, 0.15, 0.20, 0.25, is distinctly inferior in productive capacity to a lathe having the same number of feeds arranged geometrically as follows, 0.05, 0.074, 0.111, 0.166, 0.25, wherein each feed is 50 per cent greater than the preceding one.

In general the best work is obtained from a machine tool when the depth of cut is made such that the total depth of metal to be cut away is removed with one or two cuts. Such being the case the depth of cut is practically fixed and not within the control of the operator, leaving the feed and speed as the variables which he must adjust. It is important therefore that the operator be able to take a cut as heavy as the nature of the work or of the tool will permit. Mr. Taylor's paper shows that the speed of cutting is approximately inversely proportional to the square root of the feed. It needs therefore only a very elementary knowledge of mathematics to see that if the feed must be reduced to say 80 per cent of its maximum value, the output of the lathe will be only about 90 per cent of its maximum value. Or in general, if the feed be reduced from its maximum possible value by any given per cent, then the output of the machine will be reduced from its corresponding maximum value by about one-half of that per cent. We may by means of this principle compute the ratio between successive feeds which will give us any required average value for the efficiency of operation of the machine. The values so found are tabulated below:

Efficiency	Ratio	Efficiency	Ratio
98 per cent	1.08	90 per cent	1.66
96 " "	1.18	88 " "	1.92
94 " "	1.32	86 " "	2.27
92 " "	1.46		

An inspection of the table shows that when the ratio between successive feeds is about 1.1, the average efficiency of operation of the machine may be practically perfect, and that with any considerable increase of this ratio the efficiency drops off. It is the opinion of the writer that the ratio between successive feeds should always be less than 1.3 and that, more especially in the case of expensive machinery, a value of 1.2 or less is preferable.

Convenience of Feed-changing Mechanism More Important than that of Speed Changing

It has already been pointed out that the speed-changing mechanism should be of such a character that the speed changes may be easily and quickly made. In the same way it is of even greater importance that the feed changes may be easily and quickly made. In most small lathes which are now on the market quick-change gears are fitted to the screw-cutting mechanism, which are equally available as quick-change gears for the feed mechanism. In most shops small lathes are not used very much of the time for screw-cutting, and in fact nine lathes out of ten are never used for that purpose, but a quick-change gear mechanism is of much greater importance when used for the purpose of obtaining feed changes than when used for the purpose of obtaining thread changes. In the average case the operator will not have to touch the thread-cutting gear once a week, while it may be advisable to change the feed every five minutes. In the case of large lathes it is advisable to have the feed changes, not in the headstock, but in the apron in order that the workman may be encouraged to use a proper feed whenever possible.

Unlike lathes, planers are generally equipped with ratchet feeds. The successive values of the feed changes in the case of a rachet feed will necessarily run in an arithmetical and not a geometric series, the successive feeds differing by some constant decimal of an inch. So long as the amount by which the successive feeds differ is small, and the range of feeds given by the mechanism is large, a ratchet feed is perfectly satisfactory. Many boring mills are fitted with a feed mechanism driven by a friction wheel of the type generally known as a brush wheel, the driving mechanism consisting of a steel disk of 12 to 16 inches in diameter geared to the table and against the face of which a much smaller wheel edged with leather is pressed. It is obvious that if the steel disk rotate at a constant speed, the speed of the driven wheel and consequently the amount of the feed may be varied by adjusting its position. When it presses the disk near its center it will revolve slowly. When it presses the disk near its edge, it will revolve at comparatively high speed. This feed mechanism has the advantage that it gives an infinite number of feed changes over a wide range, but has the disadvantage that it is not positive in its action, and lacks sufficient power for certain kinds of work. On the whole, the best feed driving mechanism is a nest of gears so arranged that any feed within the entire range may be had by the simple shifting of one or two levers.

Strength of the Feed Mechanism

In that part of his paper discussing the force required to feed the tool of a lathe or boring mill, Mr. Taylor makes the assertion that the feed mechanism should have sufficient strength to "deliver at the nose of the tool a feeding pressure equal to the entire driving pressure of the chip upon the lip surface of the tool." This would lead to the designing of a lathe or boring mill having feed gearing of equal strength with its driving mechanism. In the case of planers and other machines wherein the tool is moved at a time when it is not cutting, these statements do not apply. It is not generally the custom among machine tool builders to design machines having such strong feed works as Mr. Taylor's ideas call for, and the writer sees no reason why such strength is necessary. The amount of force required to traverse a tool in a lathe is not proportional to the width of feed, and while it may be true for fine feeds that in the case of dull tools the traversing pressure may be equal to, or greater than the downward pressure upon the tool, this is not necessarily the case with heavy feeds. As the width of the feed is increased, the downward pressure will increase almost in proportion, while the traversing pressure will increase comparatively little, so that when the lathe is taking the maximum cut which the driving mechanism is capable of handling, the pressure required to feed the tool into the work, even though it be very dull, is much less than the downward pressure. It is the writer's opinion that a feed mechanism designed to have one-half the strength of the driving mechanism is ample for large tools, while for small tools in which of course the feed will be finer, a strength of two-thirds of the driving mechanism might be preferable.

Feed Mechanism should have "Breaking Piece"

The feed mechanism should be provided with a breaking piece whose strength will be less than that of the rest of the mechanism and which may be cheaply and easily replaced. The office of this piece is to prevent the breaking of the more costly and less easily replaced parts of the mechanism, exactly as the fuse in an electric circuit prevents the destruction of any other part of the circuit. Two forms of breaking piece sometimes used for such service are, first, a soft steel pin, driven through a shaft and hub of harder steel, which shears off when the strain becomes too great; and second, a short section of shaft turned down at its center, which twists off under similar circumstances. A breaking piece must be of such a character that it will not spoil any of the rest of the mechanism when it breaks, and should not cost more than a few cents, and should be as easily removed and replaced as a common change gear.

It must not be imagined that a feed gearing designed to have one-half the strength of the driving gear will not be strong enough to meet Mr. Taylor's requirements in all likely cases. If a tool be designed to take a maximum cut of ⅜ inch by ⅛ inch, it is not likely that much of its work will be done with such a heavy cut. If both driving and feed gearing be designed with a proper factor of safety, there is ample margin of strength for all usual conditions, while a breaking piece is the best provision against extraordinary stresses.

Pressure on Lip Surface of Tool and its Relation to Design

The pressure upon the lip surface of the tool is required in order that the designer may know, first, the strength required of the driving mechanism and frame of a machine; second,

the power required by the machine; and third, the strength required for the feed mechanism. The two materials upon which the vast majority of machine tools are called to operate are cast iron and steel. Taking first the case of cast iron, we find from Mr. Taylor's paper that the pressure upon the lip surface of the tool varies from 75,000 to 150,000 pounds per square inch of chip section in the case of soft iron, and from 120,000 to 225,000 pounds in the case of hard cast iron. The finer the feed, the greater the pressure per square inch upon the lip surface of the tool. Thus with an ⅛-inch depth of cut and 1/64-inch feed, the pressure on the tool is about 289 pounds, or 146,000 pounds per square inch. With the same depth of cut and ⅛-inch feed, the pressure on the tool is 1,358 pounds, or only about 86,900 pounds per square inch of chip section. Both these figures are given for soft cast iron. Mr. Taylor gives formulas for the total pressure of the work upon the lip surface of the tool, but the following table will be found more convenient for obtaining the required values, although the figures given are of course only approximations:

Feed, Inches	Pressure per Square Inch — Soft Cast Iron	Hard Cast Iron
1/64	140,000	220,000
1/32	120,000	190,000
1/16	100,000	160,000
1/8	85,000	135,000

In the case of soft and medium steels we find that the pressure in pounds per square inch of chip section runs from 250,000 to 300,000 pounds, being greater in the case of the finer feeds. In the case of special steels which combine high tensile strength and great elongation, it is probable that these figures would be very much exceeded. The amount of the feed and depth of cut will depend on the kind of work which is to be machined. In the case of small castings 3/16 inch is an ample allowance for depth of cut and ⅛ inch would be much more usual. In the case of very large and heavy castings the depth of cut required might run up ½ inch, and in the case of large "meaty" forgings, it may be even greater than this at some places. In those cases where the area of chip section is not fixed by the work, as in the case of stocky forgings and castings, the greatest width of feed is limited by the strength of the machine itself, which in turn is limited only by the length of the purchaser's purse. I presume it would be possible to build a boring mill or a planer capable of taking a cut an inch deep with an inch feed if anyone wished to pay for such a machine, but whether it could do the average line of work as economically as a machine taking ⅜-inch cut with ¼-inch width feed is another matter. While there is no settled rule either for the maximum depth of cut or width of feed for any particular type of machine, the matter of the size of tool used is generally definitely known. In the case of forged roughing tools the maximum chip section will be from 2 to 3 per cent of the area of the section of the tool shank. For instance, the heaviest cut which a tool forged from 1-inch by 1½-inch stock will be called upon to take will be ¼ inch by ¼ inch, or perhaps a trifle greater. In the case of tools ground from bar stock and held in tool-holders, the section of the chip may run up as high as 5 per cent of the section of the bar. Knowing the size of tool for which the tool-holders are designed, we may proportion our machine accordingly.

A matter which has great effect not only upon the quantity of work which a machine is capable of doing, but also upon its accuracy and length of useful life, is its stiffness. While it is true that if we know the maximum pressure upon the lip-surface of the tool we may design a machine for strength and have one which will probably never break in service, yet it is often better to add many times the quantity of metal which mere strength would call for, in order to have a machine with the maximum of stiffness. Stiffness in machine tool design has to do with two points, the first being the actual deflection of the metal of which it is composed under the stresses which come upon it in operation. The second is the play which invariably exists at all joints, more especially the slides of compound rests in lathes, and of saddles in boring mills and planers. The best remedy for actual deflection of metal is to use plenty of it, and to distribute it in such a way as to realize from it its maximum strength. The writer has found that an excellent method of designing such machine parts as require great stiffness is by comparison with existing tools whose operation is satisfactory. Let us assume for instance that we are to design the cross-rail of a planer. The rail is to be 8 feet between the housings and the overhang of the tool below the center of the rail is to be 30 inches. The cut is to be, let us say, ½ inch deep by ⅛ inch feed. Let us assume further that we have at our disposal a 4-foot planer, the overhang of whose cutting tool is 15 inches, and which will take in a satisfactory manner a cut ¼ inch deep by 1/16 inch feed. We now have sufficient data to satisfactorily design a cross-rail for the larger planer. If we assume that the deflection of the tool produced in the two cases should be identical in order to have the work equally satisfactory, we will find that the pressure upon the tool of the larger planer will be 4 times that upon the tool of the smaller; that both the bending and the twisting moments set up in the cross-rail will be 8 times as large, and that the distance over which these moments will operate to produce a deflection will be twice as great. Therefore, if the two rails had the same cross-section, the deflection of the tool of the larger machine would be 16 times that of the tool of the smaller. The stiffness of two bodies of similar section varies directly as the 4th power of the ratio of their homologous dimensions. Therefore, if we make the section of the rail of the larger machine similar in form to that of the rail of the smaller machine, each dimension twice as great as the corresponding dimension of the smaller rail, it will be 16 times as stiff and the deflections in the two cases will be identical. In case the rail of the smaller machine were not of the best form to resist the stresses which it must sustain, the form might be changed, the designer using his best judgment as to what effect such change might have upon its stiffness.

Cause of Vibration

Excessive vibration in machine tools is frequently due to the fact that the pressure upon the lip surface of the tool is not uniform and that the rapid but regular variations in this pressure coincide with the natural period of vibration of some part of the machine. Machines should be built so that the natural period of vibration of every part is very much higher than the period of these rhythmic variations in pressure. The fact that a machine tool of a certain design operated satisfactorily and without appreciable chattering with the old-fashioned carbon steels is no reason that it should operate equally well with high-speed steel since these variations will come very much more rapidly when high-speed steel is used. In order to make the natural period of a machine tool part higher, it is necessary that it be made compact and stocky. In other words, stiffness makes for a high vibration period. Hence, the advent of high-speed steel necessities the redesigning of many tools which were satisfactory with carbon steels. It is necessary that they be given increased weight and stockiness to prevent chattering, although their strength was already amply sufficient to provide for the cut which it is desired to take.

In designing for stiffness, it is, of course, essential that the number of joints between the work and the tool shall be a minimum; that these joints shall be so designed, if possible that wear shall not disturb the alignment of the mechanism; that they shall be provided with means for adjusting them when they become worn; that they shall be designed to wear uniformly; or, if this is not possible, they shall be so designed that they will wear very slowly. While we might dwell at length upon this matter of the design of joints and bearing surfaces, so much has been written upon it that a very few words may well suffice.

Importance of Protected Bearings

Joints and bearings in which the rubbing speed is high, naturally wear out the most quickly. If a bearing is copiously oiled, and dust and grit absolutely excluded from it, its life will be indefinite. The best form of oiling device for costly machine tools is probably a system of forced circulation, operated by a small pump, served from an amply-closed reservoir into which clean oil is returned by capillary drainage. The flooding of the bearings with clean oil will pre-

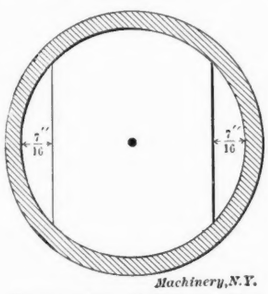
vent the entrance of grit, and absolutely prevent wear, by the prevention of metallic contact. Many bearings, particularly sliding bearings, cannot, of course, be treated in this manner, but fortunately such bearings have invariably a low speed of rubbing. Such bearings will be more durable if they are carefully scraped and fitted. They should, when possible, be so located that grit and chips will not fall upon them, or else be covered with sliding or telescoping sheet metal shields, for the same purpose. The great object to be sought is the prevention of grit on the wearing surfaces, and any scheme or appliance which accomplishes this purpose will help produce a tool which will be longer lived and more satisfactory in operation.

* * *

BADLY CHOKED EXHAUST PIPE

The illustration shows a cross-section of a badly choked exhaust pipe that was removed from an old steam engine that had been in service many years. The incident was described in the April number of *The Locomotive* as follows:

"A certain tannery in New England was fitted out, many years ago, with a small slide-valve engine, which was operated at a pressure of 70 or 80 pounds per square inch, and which proved to be adequate, until quite recently, to the wants of the plant. We do not recall the dimensions of the engine, except that the exhaust pipe was three inches in diameter, internally; nor do we know the exact date when the engine was installed. Inquiry elicited the fact, however, that no repairs had been made upon it within thirty-five years; and hence the state of affairs that we are about to describe had existed for that period, at least.



Cross-section of Exhaust Pipe Choked by Lathe False Center

"A short time ago the owners of the plant decided to throw out the old engine, and replace it with one of the Corliss type, capable of furnishing more power. Upon taking the old engine down it was discovered that the exhaust pipe was almost completely closed by means of a piece of cast iron, of the general appearance indicated by the lines shown in the accompanying sketch. On each side of the cast iron piece there was a segment-shaped space, 7/16 inch wide at its widest part; and the entire exhaust of the engine had to pass through these two openings for thirty-five years or more.

"Mechanics of the older school will see at once how the thing came about; but for the benefit of the youngsters it may be well to explain. In former years it was customary to thread all steam piping except the very smallest, by turning the threads upon it in a lathe. In order to secure the pipe properly in the lathe, it was necessary to provide a center-piece which would fit inside the end of the pipe, and in which a hole could be made, to receive the tail-center of the lathe. The center-piece was of course supposed to be removed, after the completion of the thread; but in the case now before us, this detail of the operation was forgotten, or at all events omitted, and the pipe was put in place, center-piece and all.

"The editor could use up a lot of space in trying to estimate the waste of coal that this forgotten center-piece has caused, and in comparing this loss with the cost of a good indicator; but he isn't going to. No indicator was ever applied to the engine; and we are not going to show the owners of the plant how big a mistake that omission was."

* * *

The annual prize of $5,000 instituted by King Leopold of Belgium in 1874, will, for the year 1911, be awarded for the best work in French, Flemish, English, German, Italian, Spanish or Portuguese on "The progress of aerial navigation, and the most effective means for its encouragement." The works submitted for competition must reach the Belgian Minister for Science and Art before March 1, 1911.

KNURLS AND KNURLING OPERATIONS—2

DOUGLAS T. HAMILTON*

In this second installment, which treats of speeds of knurling, number of revolutions, camming, etc., reference is made to Figs. 1, 6, 10, 11 and 12 and Table I, which appeared in the June number.

Speeds and Feeds for Knurling

When the knurl has been designed, the next thing to consider, before laying out the cams, is the speed and feed for knurling. This is a subject upon which very little has ever been published. As a general rule, a knurl can be worked at the same speed as the circular form and cut-off tools. It is good practice to feed the knurl gradually to the center of the

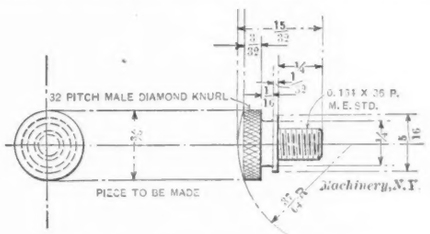


Fig. 13. Thumb-screw to be knurled

work, starting to feed where the knurl touches the work as is shown by the distance c in Fig. 12, and then to pass off the center of the work with a quick rise on the cam. The knurl should also dwell for a certain number of revolutions, depending on its pitch, and the nature of the material being worked upon. Some advocate the knurl being brought into position on the center of the work on the quick rise of the cam, and then being allowed to dwell for a certain number of revolutions; but the writer has found that this does not work satisfactorily, and cannot be depended upon. It might work when using a knurl which has a very fine pitch, on

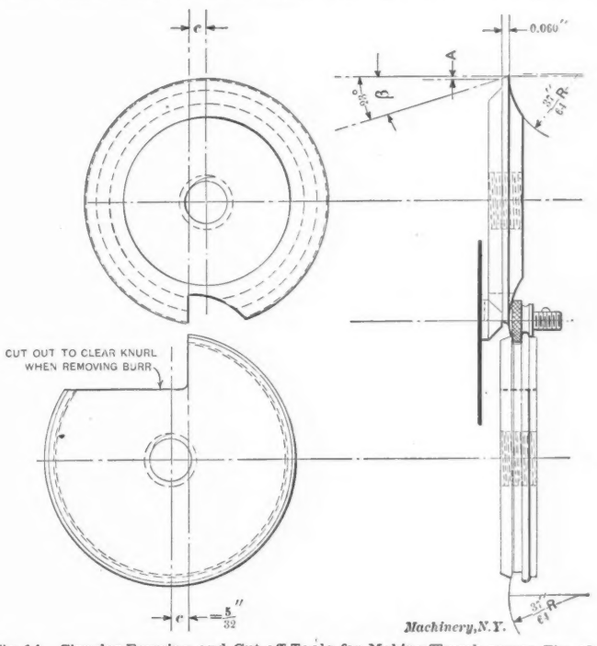


Fig. 14. Circular Forming and Cut-off Tools for Making Thumb-screw, Fig. 13

large stock, but under general conditions it will be found that gradually feeding the knurl to the center of the work will work better.

The feed required for a knurl is governed by the nature of the material being knurled, the diameter of the material, and the width and pitch of the knurl.

The surest and most practical way to find the feed required for a knurl on a certain kind of material is by experimenting. The writer has collected the results of different experiments and compiled them in Table II. This table covers practically all the different materials specified in this article, as the angle of the teeth in the knurls varies in accordance with the hardness of the material on which the knurl is used. In

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that case the feeds given in the table will be practically the same for all the materials previously specified. These feeds are only applicable when knurling from the cross-slide.

Under these conditions the depth of the tooth and the feed per revolution will govern the number of revolutions required

TABLE II. FEEDS FOR KNURLING

Diam. of Stock, Inches	Width of Knurl, Inches							
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2
	Feed per Revolution, Inches							
1/16	0.0010	0.0005	.....	.....	.....	.....	.....	.....
1/8	0.0014	0.0009	0.0005	.....	.....	.....	....	.....
3/16	0.0018	0.0012	0.0010	0.0005	.....	.....	....	.....
1/4	0.0022	0.0016	0.0014	0.0010	0.0005	...	....	.....
5/16	0.0026	0.0020	0.0018	0.0013	0.0010	0.0005		.....
3/8	0.0030	0.0025	0.0022	0.0017	0.0015	0.0010	0.0005	.....
7/16	0.0034	0.0029	0.0026	0.0021	0.0018	0.0015	0.0010	0.0005
1/2	0.0039	0.0032	0.0030	0.0025	0.0022	0.0020	0.0014	0.0008
9/16	0.0042	0.0036	0.0034	0.0029	0.0028	0.0024	0.0017	0.0012
5/8	0.0046	0.0040	0.0038	0.0033	0.0031	0.0028	0.0020	0.0016
11/16	0.0050	0.0045	0.0042	0.0037	0.0034	0.0031	0.0023	0.0020
3/4	0.0054	0.0049	0.0048	0.0041	0.0038	0.0034	0.0026	0.0023
13/16	0.0059	0.0052	0.0052	0.0045	0.0042	0.0037	0.0029	0.0026
7/8	0.0062	0.0058	0.0055	0.0049	0.0045	0.0040	0.0033	0.0029
15/16	0.0068	0.0062	0.0058	0.0052	0.0048	0.0042	0.0037	0.0032
1	0.0070	0.0065	0.0060	0.0055	0.0050	0.0045	0.0040	0.0035

to knurl. If in Fig. 12, R is the radius of the stock, d is the depth of the tooth, c is the distance the knurl travels at a given feed per revolution, and h equals $R-d$, then $c=\sqrt{R^2-(R-d)^2}$.

Let $R=0.125$ inch and $d=0.0164$ inch; then $h=0.1086$ inch. Therefore $c=\sqrt{0.125^2-0.1086^2}=0.062$ inch = rise required.

Revolutions Required to Knurl

Assume that it is required to find the number of revolutions to knurl a piece of gun screw iron, ¼ inch in diameter, with a knurl ⅛ inch wide of 36 pitch. The included angle of the tooth for gun screw iron is 80 degrees. The circular pitch is 0.0277, and, referring to Table I, the depth of the tooth is 0.0164; the distance c, as worked out in the previous example, is 0.062 inch. Then, referring to Table II, the feed per revolution for a knurl ⅛ inch wide, knurling on ¼-inch stock, is 0.0016 inch per revolution. Therefore, total revolutions required $=\dfrac{0.062}{0.0016}=38.7$ or, approximately, 39 revolutions. In some cases the feeds given in Table II can be increased 50 per cent and still give good results.

Example of Knurling Operation

Let us now assume an example of a knurling operation on the No. 0 Brown & Sharpe automatic screw machine, and find the principal dimensions of the cam for performing same. A thumb-screw, as is shown at Fig. 13, is to be knurled with a 32-pitch knurl, ⅛ inch wide, using a cross-slide knurl-holder as shown in Fig. 1.

Total Rise on Cam

It is required to find the total rise on the cam to complete the knurling, and also to cut the finished piece from the bar. The total rise can be found by means of the following formulas, derived by the aid of the diagram in Fig. 15. This shows the knurl in position on the center of the work, and the circular cut-off tool is also shown in its relative position to the work and the knurl.

Let T = total rise on the cam,
N = rise required to knurl,
S = radius of stock to be cut off,
A = distance of bevel on cut-off tool as given in Table III,
C = total rise required to cut-off $S+0.010$ inch (to approach) $+0.005$ inch (to pass center of stock) $+A$,
E = distance from center of circular tool to edge as shown, when tool is cut down below the center,
a = radius of knurl to outside diameter,
b = radius of stock minus depth of tooth in knurl,
c = distance from cutting face to center of circular tool,
$h=a+b+c$,
X = distance from center of cut-off tool to center of knurl, when it is in position on the center of the stock,
R = radius of stock,
r = radius of knurl,
R_1 = radius of cut-off tool,
R_2 = radius of knurl holder shown in Fig. 1,

TABLE III. DIMENSION A, FIG. 13, FOR DIFFERENT ANGLES OF CUT-OFF TOOLS

Thickness of Tool	β = 10 deg.		β = 15 deg.		β = 18 deg.		β = 20 deg.		β = 23 deg.	
	A	2 A	A	2 A	A	2 A	A	2 A	A	2 A
0.030	0.0052	0.0105	0.0080	0.0160	0.0097	0.0195	0.0109	0.0218	0.0127	0.0254
0.035	0.0061	0.0123	0.0093	0.0187	0.0113	0.0227	0.0127	0.0255	0.0148	0.0296
0.040	0.0070	0.0140	0.0107	0.0214	0.0130	0.0260	0.0145	0.0291	0.0169	0.0339
0.045	0.0079	0.0158	0.0120	0.0241	0.0146	0.0292	0.0163	0.0327	0.0190	0.0381
0.050	0.0088	0.0176	0.0134	0.0268	0.0162	0.0325	0.0182	0.0364	0.0212	0.0424
0.055	0.0096	0.0193	0.0147	0.0294	0.0178	0.0357	0.0200	0.0400	0.0233	0.0466
0.060	0.0105	0.0211	0.0160	0.0321	0.0195	0.0390	0.0218	0.0436	0.0254	0.0508
0.065	0.0114	0.0228	0.0174	0.0348	0.0211	0.0422	0.0236	0.0473	0.0275	0.0551
0.070	0.0123	0.0246	0.0187	0.0374	0.0227	0.0455	0.0254	0.0509	0.0296	0.0593
0.080	0.0140	0.0281	0.0214	0.0428	0.0260	0.0520	0.0291	0.0582	0.0339	0.0678
0.090	0.0158	0.0316	0.0241	0.0482	0.0292	0.0585	0.0327	0.0655	0.0381	0.0763
0.100	0.0176	0.0352	0.0268	0.0536	0.0325	0.0650	0.0364	0.0728	0.0424	0.0848
0.110	0.0193	0.0387	0.0294	0.0589	0.0357	0.0715	0.0400	0.0800	0.0466	0.0932
0.115	0.0202	0.0404	0.0308	0.0616	0.0373	0.0747	0.0418	0.0837	0.0487	0.0975
0.120	0.0211	0.0422	0.0321	0.0643	0.0390	0.0780	0.0436	0.0873	0.0508	0.1017
0.125	0.0220	0.0440	0.0335	0.0670	0.0406	0.0812	0.0455	0.0910	0.0530	0.1060

F = distance between the knurling and cut-off operations. Then

$E=\sqrt{R_1^2-c^2}$; $X=\sqrt{R_2^2-h^2}$; $N=\sqrt{R^2-(R-d)^2}$ (See Fig. 12).

$$F=X-(S+E),\quad T=N+F+C,$$

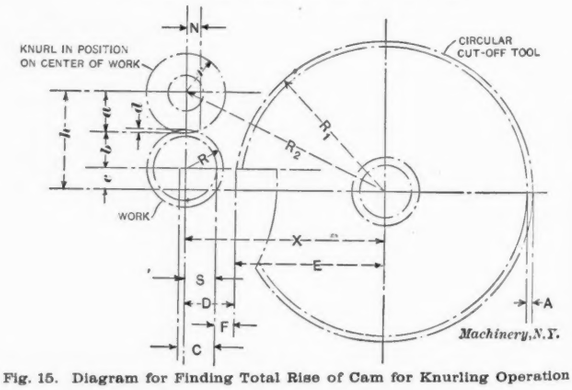


Fig. 15. Diagram for Finding Total Rise of Cam for Knurling Operation

For example, let it be required to design a set of cams to make the thumb screw shown in Fig. 13, the material being ⅜-inch round brass rod, and on which is cut a 32-pitch knurl. For the knurling operation we will use a cross-slide knurl-

CHART OF OPERATIONS AND LAYOUT OF CAMS

NAME *Knurled Thumb Screw*

MADE ON № 0 B. & S. AUTO. SCREW MACHINE

MATERIAL USED. *3/8" Round Brass Rod*

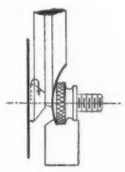
SPINDLE SPEEDS *1800* R.P.M. FORWARD, *1800* R.P.M. BACKWARD.

1 PIECE *14* SECONDS, *2571* PIECES GROSS PRODUCT IN 10 HRS

№ *60* GEAR ON DRIVING SHAFT, ____ № *28* GEAR ON WORM SHAFT.

№ ____ " " 1ST STUD. № ____ " " 2ND STUD.

CHUCKING.



DESIGNER'S INITIALS *O. T. H.*

DATE, *May 11, 1909*

DWG. №	TOOL №	REV.	TOTAL REVS. TO PRODUCE ONE PIECE. 420	HUND.	START	FINISH	RISE	FEED	OPERATIONS PERFORMED.
		21.		5	0	5			Feed stock to stop and chuck
		25.2		6	5	11			Revolve turret.
		50.4		12	11	23	0.240"	0.00476"	Rough turn (with hollow mill)
		37.8		9	6	15	0.062"	0.00184"	Form (dwell 0.01)
		25.2		6	23	29			Revolve turret
		29.4		7	29	36	0.250"	0.0099"	Finish turn (with Box-Tool; dwell 0.01)
		25.2		6	36	42			Revolve turret
		11.55		2 3/4	42	44 3/4	0.320"	0.164"x36 P	Die on
		11.55		2 3/4	44 3/4	47 1/2	0.320"	0.164"x36 P	Die off } Reverse Spindle
		18.9		4 1/2	47 1/2	52			Clearance
		29.4		7	52	59	0.075"	0.00255"	Knurl on rise
		4.2		1	59	60			Dwell with knurl while removing burr and pass over Center; rise 0.080"
		16.8		4	60	64	0.020"	0.00158"	Remove burr (with form tool) dwell 0.01
		4.2		1	64	65	0.114"		Rise to cut-off
		21.		5	70	75	0.035"	0.00207"	Point Dwell 0.01 while cutting off
		88.2		21	65	86	0.156"	0.00175"	Start cut-off }
		42.		10	86	96	0.040"	0.0009"	Finish cut-off } Revolve Turret twice
		16.8		4	96	100			Clearance
		CAMS. Lead, Front, Back							

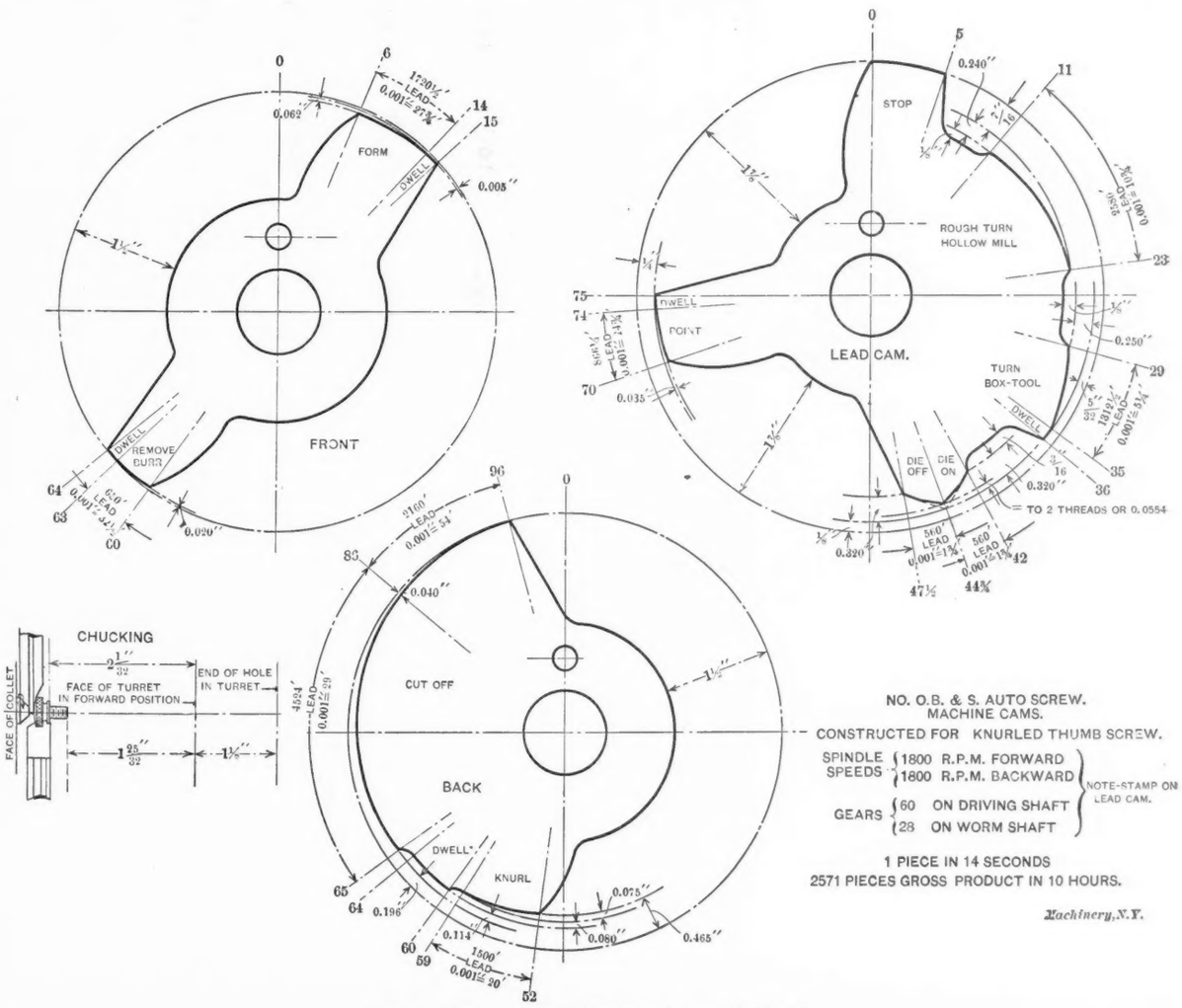


Fig. 16. Cams used for Making Thumb-screw in Fig. 13

holder, as shown in Fig. 1. R is 0.1875 inch, r is 0.375 inch, R_1 is 1.125 inch, R_2 is 1.625 inch; d is 0.0156 inch, angle on cut-off tool is 23 degrees, and the width of the cut-off tool is 0.060 inch; then, referring to Table III, A is 0.0254 inch. The cut down below the center on the circular tool c is 5/32 inch. Then, $a = 0.375$; $b = 0.1875 - 0.0156 = 0.1719$; $c = 0.1562$; $h = 0.7031$.

$E = \sqrt{(1.125^2 - 0.1562^2)} = 1.114$,

$X = \sqrt{(1.625^2 - 0.7031^2)} = 1.465$,

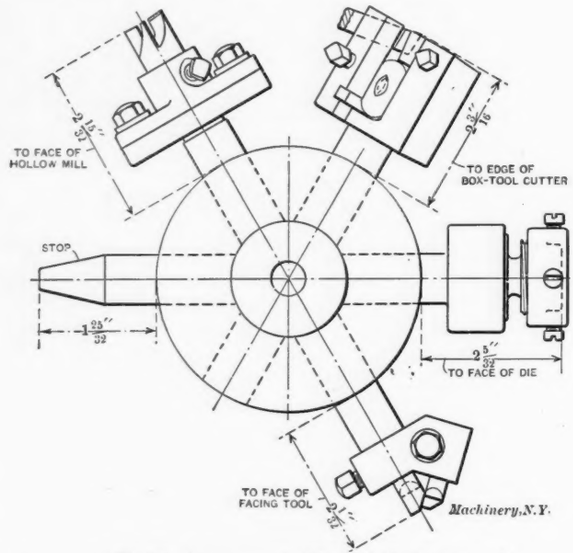


Fig. 17. Arrangement of Tools in the Turret

$N = \sqrt{0.1875^2 - (0.1875 - 0.0156)^2} = 0.075$,

$S = 0.1562$ inch, which is the radius of the shoulder left by the circular form-tool.

$C = 0.1562 + 0.010 + 0.005 + 0.0254 = 0.1966$,

$F = 1.465 - (0.1562 + 1.114) = 0.1948$,

$T = 0.075 + 0.1948 + 0.1966 = 0.4664$ inch, which is the total rise required on the cam, for the knurling and the cut-off operations.

Having determined the total rise required on the cam, we will consider briefly the other operations. The order of the various operations is given in the accompanying layout chart,

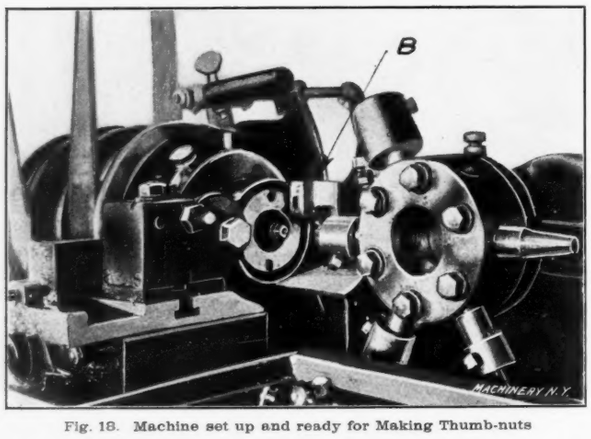


Fig. 18. Machine set up and ready for Making Thumb-nuts

and the position and type of tools used in the turret are shown in Fig. 17. As all the various operations are shown plainly on the chart very little explanation will be required.

Before starting to design the cams, the drawings of the tools suitable for performing the various operations are collected, using standard tools as much as possible. Then, after selecting the various tools, a lay-out of the circular form and cut-off tools, as shown at Fig. 14, is made. After having drawn the circular tools, and also laid out the turret operations as shown in Fig. 17, the order of the various operations is considered. Referring to the plan of operations shown in the chart, the work proceeds in the following order: Feed stock to stop and chuck, revolve turret, and rough turn with the hollow mill shown in Fig. 17; while the hollow mill is turning down the work, the circular form tool is brought in and forms the head; the form tool retreats so that it will clear the face of the hollow mill; then the turret is revolved and the finishing box-tool shown in Fig. 17 turns down the portion which is to be threaded. Now the turret is revolved and the die-holder is brought into position, and the work is threaded. By referring to Fig. 16, it will be seen that the highest portion of the lobe for the die is cut down equal to two threads, or 0.0554; this allows the die holder to draw out, and the spindle reverses on the tension of the spring (when a draw die-holder is used), which makes the die work easier, and does not crowd it on the work. After the die comes off the work, clearance is allowed between the knurling tool and the die holder, which should be ample so that the tools will not come in contact with each other. Then the knurl travels onto the work, and dwells for 0.01 of the circumference (which in this case is equal to 4.2 revolutions of the spindle), when on the center of the work. It is then forced off the work by the rise shown in Fig. 16, on the back cam. The circular form tool is now brought in again and removes the burr thrown up by the knurl; the form tool is cut away to clear the knurl. Finally, the back cross-slide travels in, and the circular cut-off tool shown in Fig. 14 starts to cut off the piece, but while the piece is being cut off, the pointing tool shown in Fig. 17 is brought in and removes the burr that has been thrown up by

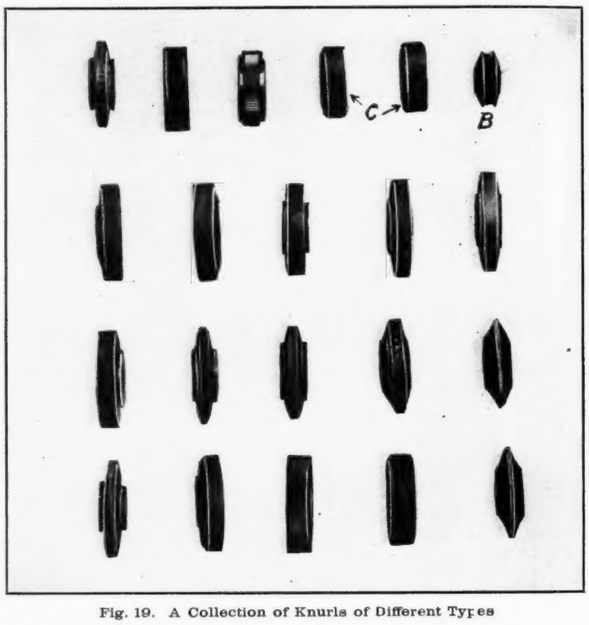


Fig. 19. A Collection of Knurls of Different Types

the die on the end of the screw; the piece is then severed from the bar, and clearance is allowed to let the cut-off tool return before the stock is fed out again.

Cutting the Cams

After the blanks have been spaced off, they are roughed out by drilling a series of holes about 1/8 or 3/16 inch away from the finishing line or by punching, which is performed on an ordinary punch-press. Then the cam is put onto a circular milling attachment. A vertical milling attachment is used in connection with the circular attachment, and a mill of the required diameter, which depends on the size of the roll on the automatic screw machine, is used for cutting the cam. The circular attachment is graduated in degrees and minutes, and it is, therefore, necessary to find the number of minutes in the number of hundredths on the lobe of the cam to be milled.

The surface of the cam is divided into one hundred equal parts, and since there are 360 degrees in a circle, one-hundredth equals 3.6 degrees, or $3.6 \times 60 = 216$ minutes.

To find the number of minutes which is equal to 0.001 inch rise, divide the total number of minutes contained in the lobe by the total number of thousandths rise. When cutting the cam, the platen of the milling machine is moved till the cutter comes in contact with the edge or face of the cam; then the cutter is fed in 0.001 inch, and the circular attachment is turned the required number of minutes, which is equal to

0.001 inch rise. The milling operation is continued in this way until the lobe is completed. Milling the cam in this manner leaves a series of little steps, or rises, which can be removed with a file, and in this way a true surface is obtained.

In the half tone, Fig. 18, are shown, in position, the tools used in making a knurled thumb nut. The cross-slide knurling tool illustrated in Fig. 1 is shown at *B* in position on the back cross-slide. In Fig. 19 is shown a variety of knurls; at *B* is shown a concave knurl made by the method illustrated in Fig. 6, and at *C* is shown a pair of knurls which will produce a diamond knurl as shown in Fig. 11, when they are used in the knurl-holder shown in Fig. 10.

* * *

DESIGN AND CONSTRUCTION OF ELECTRIC OVERHEAD CRANES—7

END CARRIAGES

R. B. BROWN

In order to calculate the strength of the end carriages, it is only necessary to find the maximum wheel pressure occurring when the crab and load are at the extreme end of the span. Take, for example, a 25-ton crane with a 5-ton crab,

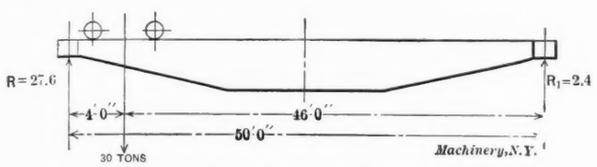


Fig. 44. Diagram for Calculating Wheel Pressure on End Carriages

where the minimum distance from center of load to center of track is 4 feet, as shown in Fig. 44.

The maximum reaction R from the traveling load will be $\frac{46 \times 30}{50} = 27.6$ tons, or 13.8 tons per wheel. Added to this is the wheel pressure due to the weight of girders, end carriages, etc., which is practically divided over the four wheels, and in the present case would be about 14 tons, or 3½ tons per wheel, making the total maximum wheel pressure 13.8 + 3.5 = 17.3 tons.

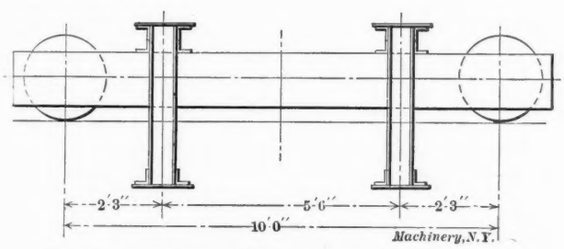


Fig. 45. Arrangement of End Carriages of Crane shown in Outline in Fig. 44

It is also necessary to know the center distances of the main girders and of the traveling wheels. The former distance is decided by the requirements of the crab, which depend to a large extent on the height of lift, and consequent amount of rope which has to be coiled on the barrel. There is no economy in cramping this dimension, and it is always a convenience to be able to take a moderately long lift without altering the standard patterns. The centers of the traveling wheels should not be less than 1/5 of the span, for electric travelers, particularly those traveling at high speeds, this proportion having been found the most suitable to resist cross twisting.

In the example just given above, the end carriage would be arranged as shown in Fig. 45. It will readily be seen that the maximum bending moment occurs at the center of the main girders, where it is equal to the wheel pressure multiplied by the distance from the center of the traveling wheel to the center of the girders = 17.3 × 27 = 467.1 inch-tons; stressing the material up to 5½ tons per square inch, giving a maximum factor of safety of 5, the modulus required would be $\frac{467.1}{5.5} = 85$.

Rolled steel channels can be used for cranes up to about 30 tons when reinforced with flange plates. When channels are not convenient, plate and angle sections are adopted, consisting of web plates and angles. Some makers substitute bracing for the webs between the girders, but it is doubtful whether any economy is effected by so doing.

The method of attaching the main girders is a detail of some importance, the various systems commonly in use be-

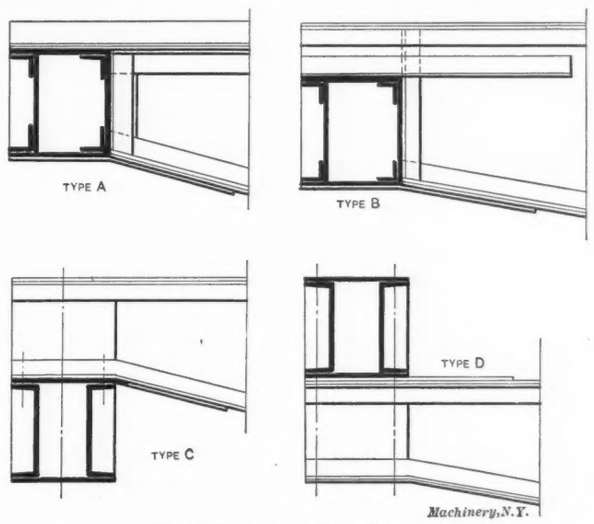


Fig. 46. Various Methods in Use for Attaching the Main Girders to the End Carriages

ing shown in Fig. 46. Type A forms a very neat connection and is particularly suited for cranes up to about 15 tons. The rail and top flange plate should be run across the top of the carriage as shown, and a substantial gusset ought to be fixed to the lower flange to stiffen the joint. The two sides of the end carriage are tied together by heavy diaphragms, as shown, and this arrangement to some extent ensures the outer member of the carriage taking some of the weight. The tendency for the inner members to take the full load is, however, one reason why this construction is often avoided for heavy cranes, in favor of the method shown as type B, which is the strongest and most satisfactory form for fixing the girders. It will generally be found in this design that the shallowest construction that can be employed at the ends of the girder is sufficiently strong to carry the whole load, even if it were concentrated at the extreme end of the girder, and this fact alone ensures both members of the end carriages getting an equal load, and at the same time does

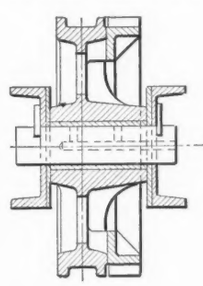


Fig. 47. Traveling Wheel with Bushing running Loose on Pin fixed to the Framing

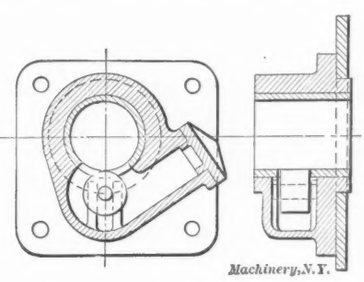


Fig. 48. Self-lubricating Axle Boxes for Crane Traveling Wheels

not encroach too much on the head room, for which reason the construction shown in type C is seldom adopted. The attachment illustrated in type D is strong and inexpensive, but occasionally has the fault of limiting the end travel of the crab.

Wheels, Axles and Bearings

The most convenient sizes of traveling wheels taken from practice seem to be

18 inches diameter for cranes up to 4 tons.
21 inches diameter for cranes up to 7 tons.
24 inches diameter for cranes up to 25 tons.
30 inches diameter for cranes up to 25 tons and above.

The 18- and 21-inch wheels should be made of cast steel, in order to withstand the wear on the tread. The 24-inch wheels are sometimes made of cast steel also, but general practice inclines to steel-tired wheels for this and larger sizes.

The strains due to shrinking both in the tire and center appear to be very great, and it is for this reason that the centers are made heavy to avoid cracking. A very convenient position for the driving spur is to bolt it directly to the traveling wheel, and is a better arrangement than casting it on the center. Some makers key the wheel onto the axle, outside the carriage, so that it can be easily removed; this arrangement, however, rather interferes with a neat connection for the platform at the ends. When the spur is attached directly to the wheel, allowance should be made for the consequent unequal loading on the sides of the end carriages.

Some makers bush the traveling wheels and run them loose on pins fixed to the framing, as shown in Fig. 47. This method allows the wheels to be easily withdrawn for repairs, and simplifies the lubrication, which, however, should consist of grease instead of oil, owing to the fact that the latter is apt to run out when the bushes have worn slightly oval.

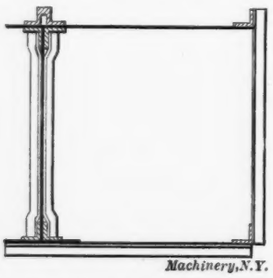


Fig. 49. Section of Girder suitable for Light Cranes of Long Spans

The diameter of the axles must be sufficient to resist bending from a distributed load, and at the same time have enough bearing area to keep the pressure below 1,000 pounds per square inch. Large cranes, and, in the case of some makers, all cranes are fitted with self-lubricating axle boxes, of the type shown in Fig. 48. The roller shown in this illustration is of cork, with a hardwood spindle. The slot in the casting requires to be well made, or occasionally the roller may become jammed and ineffective.

Platforms, Brackets and Traveling Gear

The design and arrangement of the platforms and brackets either improves or detracts from the appearance of a crane, to a considerable extent. A variety of opinions seems to exist on the question of platforms, and while one engineer requires platforms on both sides of a one-ton traveler, another may be satisfied with one platform for a 25-ton crane. In the case of light high-speed travelers, it has been found both convenient and economical to have only a small platform over the cage, to stand on when examining and oiling the crab, the longitudinal shaft and axles being oiled from below, or from a platform fixed to the shop end wall.

If, however, a platform must be fixed to cranes having light lattice or single web plate girders with over forty feet span, it will be found that the section necessary to carry the load itself, is seldom sufficient to withstand the torsional stress due to the platform without deflecting laterally. The best means of overcoming this difficulty, which practically applies to all sizes of cranes with single web girders, is to attach a light subsidiary lattice girder to the main girder by horizontal bracing, as shown in Fig. 17 (April issue). The section employed can be very light. The diagonals, or tension bars are formed of light angles in preference to flat bars, to ensure rigidity and freedom from vibration; since they are strong enough to take compression, they obviate the necessity of counterbracing the central bays.

A section of a special girder is shown in Fig. 49. This has been found eminently suitable for light cranes of long span, traveling at a high speed. In this design it will be seen that the top flange is really a chequer-plate platform, one side being riveted to the web and the other to the lattice bracing, forming the front, the lower side also being braced. The increased width of the top flange gives a lateral stiffness sufficient to withstand the most severe strains.

The various forms of platform brackets in use are shown in Fig. 50. The advantage of each type of bracket is a matter of opinion, but it is generally considered, however, that type *A* is the simplest and best for plate girders, and more in accordance with the type of bracket which is employed to carry the traveling motor. Type *B* is formed of flat bars about $3 \times \frac{3}{4}$ inch and makes a very suitable bracket for box lattice girders, where it can be bolted onto the vertical members of the structure.

Timber is generally employed as a platform, on account of its lightness and cheapness; it also gives the best foothold. When cranes are working in the presence of fire, ¼-inch steel chequer plates are generally used in place of timber, and carried on steel brackets in the same manner.

A type of platform much employed on the European continent is made up of perforated steel screen plates, usually about 3/16 inch thick, which possess the advantage of lightness and good appearance, while the cost is only very slightly in advance of rolled chequered plates. This type is, however,

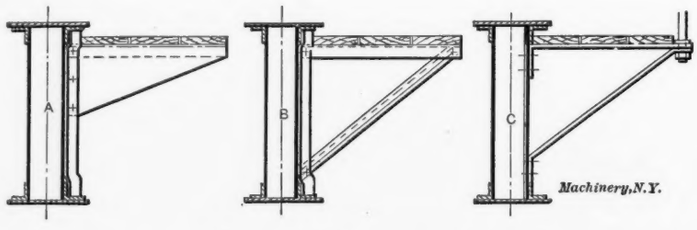


Fig. 50. Types of Platform Brackets

most suitable for those cranes having lattice braced platform girders, which give the close support a plate of this description requires.

The traveling motor ought, theoretically, to be placed in the center of the drive. Cranes up to 50 feet span are, however, sometimes driven with the motor fixed at one end, but since it adds very little to the cost, it is best practice to place the motor in the center for all cranes over 30 feet span.

Whenever possible, the gearing ought to be confined to two reductions, and in order to do this, the motor should not be speeded above 600 revolutions per minute. Ordinary plummer blocks form a suitable type of bearing for the cross shaft. The bearings are usually placed on about 10-foot centers.

When using flanged couplings for this shaft in conjunction with timber platforms, there is always the disadvantage of either using somewhat high plummer blocks, or cutting the platform away to clear the flange, and this difficulty can best be avoided by using ordinary split muff couplings.

* * *

In 1898 there were not more than 200 automobiles made and put into use in the United States. In 1909 the total number of automobiles made and sold in the United States will approximate 82,000. The effect of the development of the automobile on the reduction of weight of prime movers may be appreciated when it is considered that less than thirty years ago prime movers weighed as much as 800 or 1,000 pounds per horsepower developed, and that the modern automobile engine has been reduced in weight to well under ten pounds per horsepower developed, and has shown its great reliability by running for days without stopping. The average horsepower of the automobiles produced in 1909 is about twenty, the 82,000 machines making an aggregate of 1,640,000 horsepower. At the beginning of this year there were in use in the United States over 184,000 automobiles, aggregating close to 4,000,000 horsepower.

* * *

The first aerial pleasure yacht ever built has recently been ordered from the firm controlling the rights of the Parseval type of air-ships, and is being built for a customer of Berlin, Germany. The air-ship will be used for pleasure trips during the present summer.

PACKING MACHINERY FOR EXPORT

In this the second article on packing machinery for export (see MACHINERY, February, 1909) we illustrate the packages employed by a number of machine tool builders, which have been especially photographed for MACHINERY. We feel that the subject still is an important one, notwithstanding the depression in export trade of machinery. Even though European countries buy less and less of our machines proportionally as years go by, there is no reason for our manufacturers to neglect foreign business. With proper encouragement a machine tool trade can be worked up in other countries besides Europe. South America is a very promising field for future sales. It is a land practically untouched by American manufacturers, and now is the time when we should be doing the initial work to build up a trade that should grow with years and become as important in time as the European trade. As being of particular significance now, we quote from a book entitled "Aids to Shippers," published by Oelrichs & Co., New York:

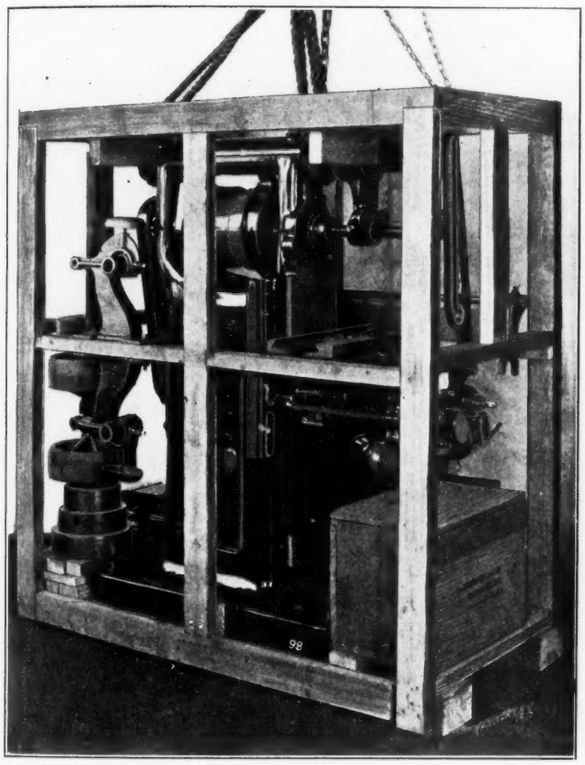


Fig. 1. Kempsmith Knee-type Milling Machine in Framework of Export Packing-case

Fig. 2. View of Packing-case for Kempsmith Knee-type Milling Machine, showing Opening at Top for Handling

"Commerce flows along the lines of least resistance, and those manufacturers, merchants, farmers and miners will be most successful in extending their markets, who deliver their goods to the purchaser wherever wanted. Nothing has contributed so much to the material wealth of the entire world as the tremendous strides made in transportation facilities during the last century, and transportation has become the most valuable commodity of the present day, as in nearly every instance the cost of carrying an article to its ultimate destination determines the question of its sale. Too much stress cannot be laid upon the care that should be exercised in packing merchandise exactly in compliance with the wishes of purchasers, no matter how trivial they may seem. If, for instance, a buyer should instruct a shipper to arrange his package in such a way that a certain weight or size be not exceeded, it is no doubt that the goods are to be carried on mule back or similar conveyance to the interior. A request especially from South American countries will frequently be made that but one kind of goods be placed in each package, and this also should be strictly carried out. Failure to observe this rule results in heavy fines by customs authorities, as the laws of the respective countries demand that each kind of goods imported therein must be packed in a separate package, and forbids the placing of different kinds of merchandise in one receptacle."

The packing of a milling machine for export as practiced by the Kempsmith Mfg. Co., Milwaukee, Wis., is illustrated in Figs. 1 and 2. At one time this company exported 90 per cent of its product, and its export trade now averages about 30 per cent, so that of necessity it has developed methods of packing which reduce complaint from defective shipping to a minimum. In the past five years it has received only one complaint of trouble resulting from packing.

The milling machine to a certain extent is self-contained, and therefore lends itself very well to a compact, substantial package, and this condition is improved for export by partial dismantling. The table is removed and placed in a low place in the case, and the knee is run down to a low position on the column. The counter-shaft is packed at the rear of the machine with the pulleys at the bottom, as shown in Fig. 1. The loose parts are carefully packed with a liberal amount of excelsior in a box within the main case. This illustration also shows the method of framing and bracing. The lumber used is white pine, as this timber does not split and is in other respects better for the purpose than hemlock or other woods. The machine is securely bolted to 6 x 8 inch skids, and the frame is of 2 x 4 inch material. The corner posts are further supported by intermediate cross and upright posts, and the top framing is placed against the overhanging arm so as to support the machine in case it is turned over on its side.

The sheathing is 1¼ inch lumber nailed vertically, as shown in Fig. 2. Three strips of 1/16 inch x 1 inch band iron are passed around the bottom, top and middle of the completed case. Two of the top boards of the case are screwed instead of nailed, this being done for convenience in removing them and thus providing an opening for inserting ropes or other tackle appliances for handling the machine. This feature is known to customers abroad, and facilitates the handling of the machine. An end board shown in the same illustration is provided, which is likewise screwed, with notice to the custom officials that the same is the proper place to open the case for inspection.

All finished surfaces of the machine are thoroughly slushed over both externally and internally to protect them from dampness. It is not safe to leave a finished surface on the interior of the machine, as the damp salt air can work just

as much injury to parts on the interior as to those on the exterior, if not protected. For the overhanging arm and upper finished surfaces a special brand of slush is used which hardens soon after application. The reason for this is that these parts are subject to exposure in handling both in shipping and receiving at the other end. The hardened slush is not easily rubbed off by the use of ropes, etc., in handling, and therefore protects these parts from exposure and rust, even though subjected to considerable wear. This hardened slush is easily removed with benzine.

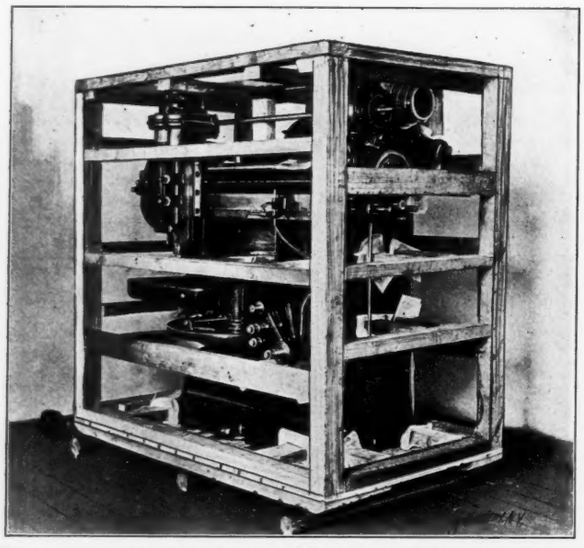


Fig. 3. Framework of Foreign Export Package for Fellows Gear Shaper

Figs. 3 and 4 illustrate the framing and exterior of the package used by the Fellows Gear Shaper Co., Springfield, Vt., for protecting gear shapers. The gear shaper, like the milling machine, is largely self-contained, and does not offer serious difficulties in the matter of substantial packing, and very little dismantling is necessary. The frame work is well braced with about 4 x 6 inch stuff and 2 x 4 inch pieces between. Substantial skids are provided, and the sheathing is nailed vertically, as illustrated in Fig. 4.

The package illustrated in Fig. 5 is a remarkable example of compact packing of a tool, which to the ordinary observer

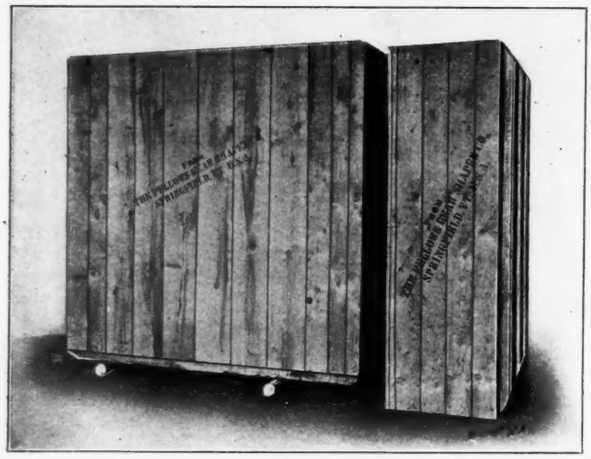


Fig. 4. The Same Case shown in Fig. 3, Boarded up

would seem quite incapable of being put in such close compass. This package is the one employed by the W. F. & John Barnes Co., Rockford, Ill., for its upright drills. The machine, which is a 25-inch drill, is packed into a case measuring 76 x 49 x 12½ inches, the gross weight of which is about 1,300 pounds. The company has lost only one of its drills thus packed for export. It will be observed that the base is removed as well as the table and packed alongside of the frame with the cones, feed gearing, etc. Other parts are packed in the interstices so that the amount of waste space is reduced to a minimum. This can be judged from the fact that the cubic contents is only about 27 cubic feet and the weight is 1,300 pounds, or 48 pounds per cubic foot. The case is built up of lumber 1¼ inch thick.

The Cincinnati Machine Tool Co. employs a very strong framework for its upright drills, covering same with six- or eight-inch wide flooring nailed about six inches apart. The company has found this style of open package satisfactory. It enables the freight handlers to see what they are handling, and if a breakage occurs between Cincinnati and New York it saves shipping the broken machine all the way to Europe. Practically no breakages are reported, but notwithstanding the satisfactory experience, the foreign dealers request closed boxes, and now the company is packing in the same way as before and closing the cases tight.

The Ingersoll Milling Machine Co., Rockford, Ill., builders of heavy milling machines of the planer type, dismantle the

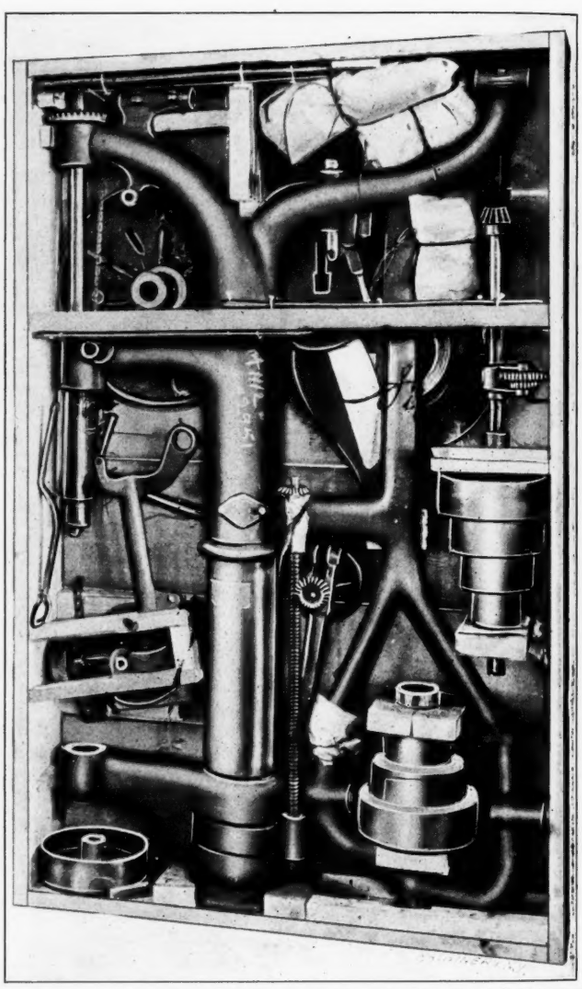


Fig. 5. Twenty-five-inch Upright Barnes Drill packed for Foreign Shipment. Note the Compact Arrangement of Parts and Little Waste Space

machines for their export trade and pack the parts in boxes made of 2 x 6 inch dressed and matched lumber, making the boxes perfectly tight.

The Rockford Drilling Machine Co., Rockford, Ill., dismantle all its machines shipped abroad and pack in substantial boxes, bracing the large parts thoroughly. This method has the objection of requiring the foreign customer to reassemble the machine, and where this is done by users, trouble sometimes arises through improper assembling. The advantage from the point of the manufacturer lies in that the machines do not occupy so much cubic space as otherwise, and therefore the freight rates are lower.

Fig. 6 illustrates the package employed by the Edwin Harrington, Son & Co., Inc., Philadelphia, Pa., for their long lathes. The machine in the package is the 28- and 48-inch extension lathe, ordinarily used as a lathe of 28-inch swing. In packing this machine the head- and tail-stock are put in one box, while the carriage and small parts are packed in

other boxes. The lead screw is left in place on the side of the bed, and boxed in. The illustration shows the bed upside-down. This package only partially protects the machine, the bottom being open and the frame work being held together by strong cross-ties. The upper part of the bed or finished surface is protected from dampness by boarding. In conclusion we quote again from "Aids to Shippers" on the importance of marking packages:

"It is an established fact that the marking of packages plays a considerably more important part in export shipping than most American manufacturers and export merchants are willing to credit. As an instance, we desire to call attention to the fact that several South American countries require that all marks on the packages must be stenciled, brush or other kind of marking being prohibited by law. Some countries, on the other hand, demand that the distinguishing marks and numbers, etc., be placed on the four sides of each package. Again, some demand that the net and gross weight in kilos appear on each case, together with a number, which latter must correspond with the number of the same case given in the consular documents. It is needless to observe that where the laws of the different countries demand such markings, failure to comply with the regulation always results in fines, delays and many other petty annoyances at destination, the fines, in many instances, exceeding the value of the goods considerably. In all instances every case must be distinctly marked with the port of destination in full, this requirement emanating from the steamship companies and being covered by the term 'Port Mark.'"

* * *

The gas pressure in the powder chamber of the Springfield rifle, model 1903, for the latest pattern cartridge, is about 49,000 pounds per square inch. What this means may be inferred from the following abbreviated directions for cleaning the arm, contained in the pamphlet issued for the instruction of army officers: "Use the cleaning rod and small patches of canton flannel and clean the bore thoroughly with patches soaked in a saturated solution of soda and water. Then thoroughly dry the bore and remove the soda solution by the use of dry patches and finally oil the bore with patches soaked in cosmic oil. Twenty-four hours after the first cleaning, the bore should be again cleaned as described above, as it has been found that the powder gases are probably *forced into the texture of the steel*, and will, if the second cleaning is not resorted to, cause rusting no matter how thoroughly the bore may have been cleaned at first."

A RIVETING FIXTURE

ORONO

The accompanying engraving illustrates a fixture which was designed for use in a pneumatic riveter. The work is shown in the two views in Fig. 1, and consists of an oblong casting with a half-round top, having a hole *B* extending through it and a hole *C* in one end. The five small holes *D* were drilled in the center of the casting and about two-thirds of the way through. The side *A* is finished, and the holes *B* and *C* are a gage distance from this surface. The face *E* is also finished square with *A*. In the finished piece, small springs were placed in the lower portion marked *F* of the holes *D*, and it was necessary that the outer part of the holes *D* should be plugged in order to have a continuous ring of metal around the top part. Small brass disks were inserted in these holes and expanded by the riveter sufficiently to tightly fill the hole. Fig. 2 shows a top view of the fixture; Fig. 3, an end view, and Fig. 4, a side view with lever *G* removed.

The fixture consists of a cast iron base, planed off on the bottom, having a round boss *H* which fits into the bed of the riveter. The base is dovetailed, as shown, for the slide *I*,

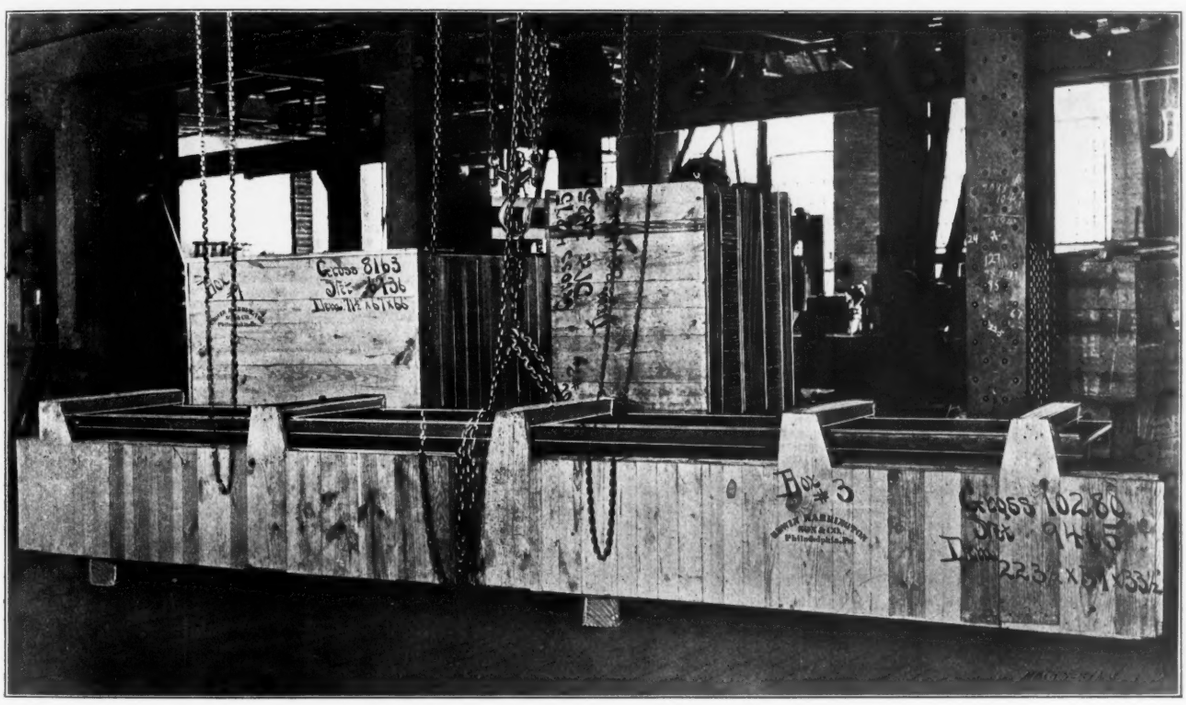


Fig. 6. Extension-bed Harrington Lathe packed for Export

from which a lug projects upward and carries the studs *a* and *b* on which the work is placed. These studs fit the two holes *B* and *C* of the work, and have shoulders against which the side *E* of the work stops. The bottom *A* of the work rests on the hardened tool steel plate *c*. Fig. 4 shows the work in position so that the hammer *J* of the riveter, in descending, will expand the disk in the second hole in the work; when this is done, the slide *I*, carrying the work, is moved along so that the third hole will be in line with the hammer of the riveter, and so on, for the other holes. The stock left between the holes in the work, after drilling, is so small that it is very necessary that the hammer be exactly in line with the hole containing the disk to be expanded, for, if in riveting, the hammer strikes the solid part of the casting, it will crack it. For this reason, it is necessary that the slide should be fed forward an exact amount each time, and that it should be properly indexed in this position. This is accomplished by the lever *G*, which is pivoted to the base of the fixture at *d*. The pawl *K* is pivoted to the lever *G*, and meshes into the rack which is cut in the plate *c* fastened to the slide *I*. To the outer end of the lever *G*, is connected the index pin *L* which has a bearing in the boss *e* on the base of the fixture. The plate *M* is fastened to the slide *I*, which car

ries the work, and has five small holes in its side, spaced the same as the holes *D* in the work, and so located that when the index pin *L* is in any one of them, the corresponding hole in the work is in line with the hammer *J* of the riveter. The screw *f* is adjusted so that when the end of the lever *G* stops against it, the pawl *K* will have moved the slide *I* such an amount that the hammer *J* will be directly in line with the hole in the work. This position is shown in Fig. 2. When the lever *G* is thrown in the direction of the arrow, the index pin enters the hole in the plate *M* on the slide, thus locating it accurately in this position. When the lever *G* moves to the end of its throw in the direction of the arrow, the pawl passes almost to the point of the next tooth. In feeding the slide forward for the next hole in the work, the lever must swing in the opposite direction a sufficient amount to move the pawl *K* from the point to the bottom of the tooth in rack *c*, before starting the slide forward; this movement is sufficient to withdraw the index pin *L* from the hole in the plate *M*, thus making sure that the index pin is withdrawn before the slide is caused to move. The mechanism to clamp the work in position, consists of a small slide *g*, dovetailed into the main slide *I*. The clamp *N*, pressing against the work, is pivoted at the center to the slide *I*, and joining the lower end of this clamp and one end of the small slide *g* is the connection *h*. The cam *O* is mounted on the slide *g*, and its face works against the surface of the plate *M*, which is fastened to the slide *I*. Fig. 2 shows the small slide *g* forced forward by the action of the cam *O* against the plate *M* which causes the clamp *N* to be pressed against the work as shown by the full lines of Fig. 4. The dotted lines show the position of clamp *N* when the cam is released. The coil spring *i* forces the slide *g* backward at this time.

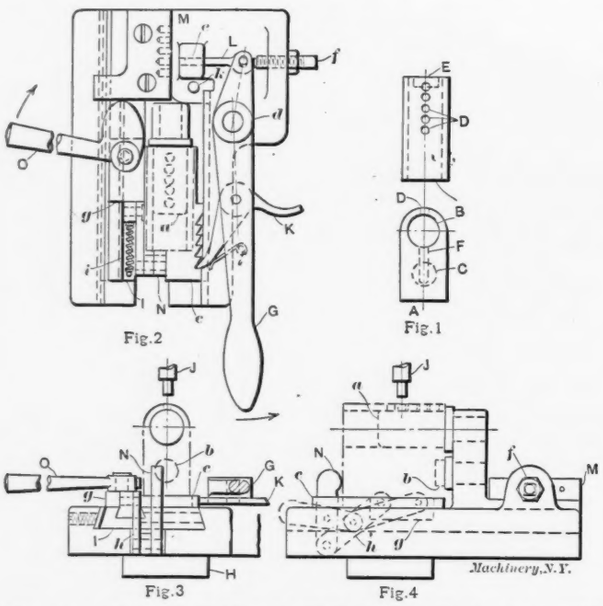


Fig.2 Fig.1 Fig.3 Fig.4

Figs. 1 to 4. Fixture for Holding the Work shown in Fig. 1, and Accurately Indexing it when Riveting Disks in Holes D

The operation of the fixture is as follows: The work is placed upon the studs and the cam *O* is swung in the direction of the arrow, thus clamping the work in position. The riveter is started and the disk in the first hole expanded. The riveter is then stopped, and the lever *G*, which at this time is to the right of its movement with the index pin *L* in the first hole of plate *M*, is swung to the left until the end brings up against the stop-screw *f*. This movement withdraws the index pin *L*, and feeds the slide *I* forward by means of the pawl *K* working in the rack *c* on this slide. The lever *G* is then thrown to the right, and the index pin *L* passes into the second hole of plate *M*. The riveter is again started and the disk in the second hole is expanded. These movements are repeated until the disks in the five holes have been expanded. The cam *O* is then released, thus throwing the clamp *N* down and allowing the work to be removed. The operator, having his right hand on the lever *G*, presses against the end of the pawl *K* with his finger, thus throwing it out of engagement with the rack *c*, and, at the same time, throwing lever *G* in a direction opposite to that of the arrow until it brings up against the stop-screw *j*, thus withdrawing the index pin *L* from the hole in the plate *M*. Another casting is picked up with the left hand, and pushed onto the studs *a* and *b*, and, at the same time, the slide *I* is moved back against the stop-pin *k* which is so located that the first hole in the work is in line with the hammer *J* of the riveter. The end of the pawl *K* is now released, and the spring shown forces it into mesh with rack *c*. The lever *G* is swung in the direction of the arrow, thus causing the index pin to pass into the first hole in the plate *M*. The cam *O* is moved in the direction of the arrow, thus clamping the work in position, and the train of operations repeated.

In operation, the fixture proved to be very rapid and accurate, and gave satisfaction.

* * *

TEACHING HORSE SENSE

In a communication to the *Engineering News*, George H. Follows, Professor of Machine Design at the School of Applied Science, Carnegie Technical School, Pittsburg, Pa., expresses some ideas regarding the teaching of "horse sense" in technical schools, which are of interest to all who have given any thought to the question, and which suggest the lines along which further improvement may be made. One fault with technical instruction as usually imparted is that no "sense of values" is developed. The technical graduate, as well as the college graduate in general, has but a dim recognition of essentials and non-essentials at the time when he leaves his Alma Mater. He does not know things of prime importance from those of secondary value. He has usually an exaggerated idea of the value of his college training, and of the knowledge that he has assimilated during his years at a technical school. When engaging in practical work, he is likely not to be able to distinguish a big thing from a little thing and at first accomplishes little, because he uses up his time and energies with an unprofitable struggle with trivial matters; in other words, he lacks good "horse sense."

While it is not possible to teach "horse sense" in the abstract, it is possible to develop a sense of judgment in the student provided the instructor himself possesses the qualities necessary for imparting such instruction. This instruction of common sense can be made effective by introducing a course that does not deal exclusively with theoretical considerations but deals with engineering as it actually appears in commercial life. The students should be taught that mechanical drawing is only a means to an end and by no means the end itself. In fact, they ought to be taught that engineering itself is only a means to an end, and that unless mankind is enabled to live happier and better lives as a result of industrial and engineering progress, the object to which the engineer devotes his energies fails of its purpose. They should be given an idea of the organization of engineering concerns and be made to understand that when they first enter practical life, they will be likely to occupy very subordinate positions. Of course, with this instruction in shop organization also follows general instruction in shop management and shop systems, and efforts should be made to impress on the student the true difference between system and "red tape," that is, in other words, the difference between essentials and non-essentials. Last but not least, the student who enters practical life from a technical school needs to be given an idea of the conditions and requirements of the human element in the industries and an understanding of the fundamental principles of economics as they apply to the cooperative work of society. It is evident that it is difficult to obtain competent instructors for this kind of instruction, because experience alone would equip a man to teach successfully along these lines; but undoubtedly students who had had ideas of this kind imparted during their years at school would enter practical work with a truer conception of the conditions of life than the majority of technical and other college graduates now have.

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The three-hundredth anniversary of the landing of the Pilgrims at Plymouth, Mass., will be celebrated by a world's exposition in Boston in 1920.

BORING MACHINE PRACTICE IN THE SHOPS OF THE LANDIS TOOL CO.

Anyone who has occasion (for business or other reasons) to visit any considerable number of machine shops in the course of the year, soon learns to grade these shops in his mind with respect to the interest of the work carried on, and the progressiveness and openmindedness of those responsible for the administration of the plant. There are many shops where the mechanic knows beforehand that a visit will be unprofitable, so far as mechanical inspiration is concerned. There are other shops which he has set down on his mental chart as oases in the desert, where he may expect to make refreshing discoveries in shop practice, and to come in contact with alert, intelligent workmen and shop managers. In any such classification the Landis Tool Co., of Waynesboro, Pa., must stand well toward the top. The writer found enough of interest there on a recent visit to the plant to fill many pages of MACHINERY. Much of the material collected is not of a startling or revolutionary nature, but it shows ability in the devising of manufacturing methods, and should therefore be interesting to others engaged in similar work. This material will be published as a series of short articles, each dealing with a separate subject.

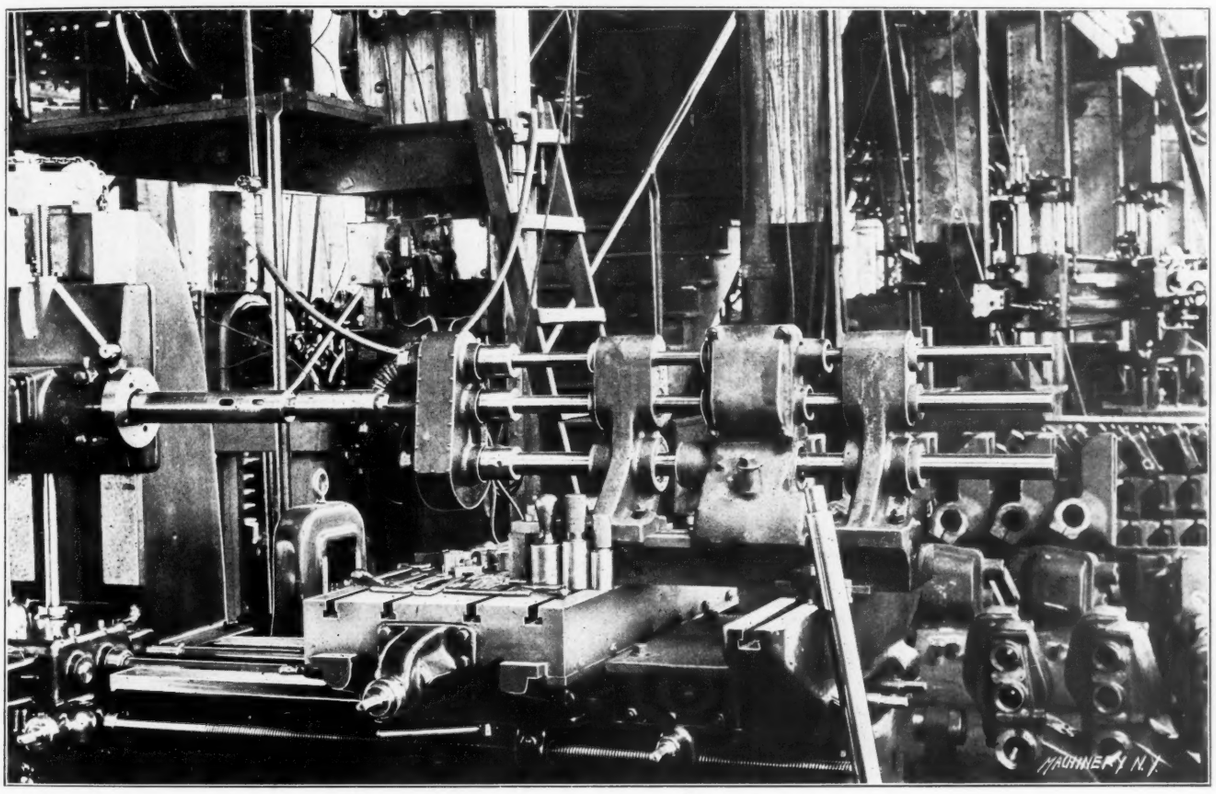

Fig. 1. Lucas Boring Machine with Special Head for Driving Three Bars

One of the things that a live mechanic is always trying to do is (to quote Emerson) "to make two blades of grass grow where one grew before"—in other words, to take two or more cuts where but one was taken before. In pursuance of this idea, various standard machines have been developed into multiple spindle and multiple tool designs. We thus have the multiple spindle drill, the multiple spindle screw machine, the lathe with several carriages and tool rests, and numerous other developments of the same character. It has remained for this firm, however, to devise a multiple spindle boring machine. This was accomplished, as shown in Figs. 1 and 2, without making any change in the ordinary single spindle boring machine other than to provide it with suitable boring bars and driving heads for taking multiple cuts.

Fig. 1 shows a Lucas boring machine, rigged for machining holes in the gear-driven head-stock of the Landis grinding machine. These holes are being bored in a jig built in accordance with the now well-established principle of guiding the boring bars in bushings, so that they are independent of the alignment of the machine spindle. A base is provided for the jig having clamping surfaces identical with those of the work-table on the finished grinder. At each end of this base is clamped a bracket, having bushing holes accurately spaced to the dimensions desired for the holes in the finished head-stock. The head-stock casting is clamped on the base between these standards by the same means and in the same way that it will be clamped in the finished machine. When a jig made in this way is accurately constructed and properly used, assurance is given that the holes bored in the work will be in proper alignment and proper position, irrespective of the accuracy and alignment of the boring machine.

The particular feature of interest in this operation is, of course, the multiple spindle drive, which permits the boring of all three holes simultaneously. This is a very simple contrivance, as may be seen. It consists merely of a casing having three spindles spaced to agree with the holes to be bored in the work, all connected by means of suitable enclosed gearing. The central spindle is lined up with the spindle of the machine and is connected to it with a flexible coupling, which permits the bars to guide themselves in their bushings without reference to the spindle. As the main spindle of the machine is fed forward, it presses against the multiple boring head and feeds the three bars simultaneously through the cut, so that three chips are taken where but one was taken before.

A somewhat different arrangement for doing similar work is shown in Fig. 2, where the tail-stocks are being bored for the dead center spindle. Here it is not a case of boring two or more holes in the same casting, but of boring two castings simultaneously. A double base-plate is provided, having ways on each side identical with those provided on the work-table of the grinder. To these ways, as in the previous case, are bolted brackets carrying guiding jig bushings, between which are clamped the tail-stock castings to be bored.

A construction for the boring head different from that in the previous case is required on account of the fact that two spindles instead of three are used. Where three spindles are employed and the drive is led direct to the middle one, the thrust of the cut is approximately balanced, so that there is no tendency to throw the boring bars and the head out of line; but where two spindles are used, one of them driven direct

and the other connected by gearing, the thrust of the cut for the latter is out of line with the spindle of the machine which furnishes the pressure for feeding. There is thus a tendency to twist the boring head around and cramp the bars. In the case shown, this difficulty is avoided by mounting the boring head on ways, machined on an extension of the base plate on which the work is mounted. These ways serve to keep the boring head lined up properly with the boring bars, even under a heavy eccentric pressure from the cut. The feeding of the main spindle of the boring machine moves the head along the ways on the base-plate, and thus feeds the boring bars through the work.

The pair of tool heads shown on the platen of the machine in Fig. 2 are of considerable interest. They are of the split variety, making it possible to mount them on the bar without dismantling the setting or removing the bars or the bushings. The construction is more plainly shown in Fig. 3, which illustrates the head shown at the right-hand corner of bar, so that it is not held by the clamping action. To give further assurance of a positive drive, the cross pin *F* is provided in the bar; this drives the head by means of notches fitted to receive it, as shown.

The tool head shown in Fig. 3 is intended for turning the outside of the foot-stock spindle boss. The turning tool used is shown in place at the right of the engraving. Another head of identical construction, but provided with facing cutters, is also shown on the platen of the machine in Fig. 2. This is used for finishing the ends of the bosses on the work.

This combination of double spindle boring attachment, and quickly changed, solidly held tools, makes the operation of machining these castings a very expeditious and accurate one.

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A press report from Dysart, Iowa, states that Nathan Wilson has invented a process for welding copper and steel. He exhibited a hammer which is composed of a copper head and steel face, and he claims that his process of welding is the

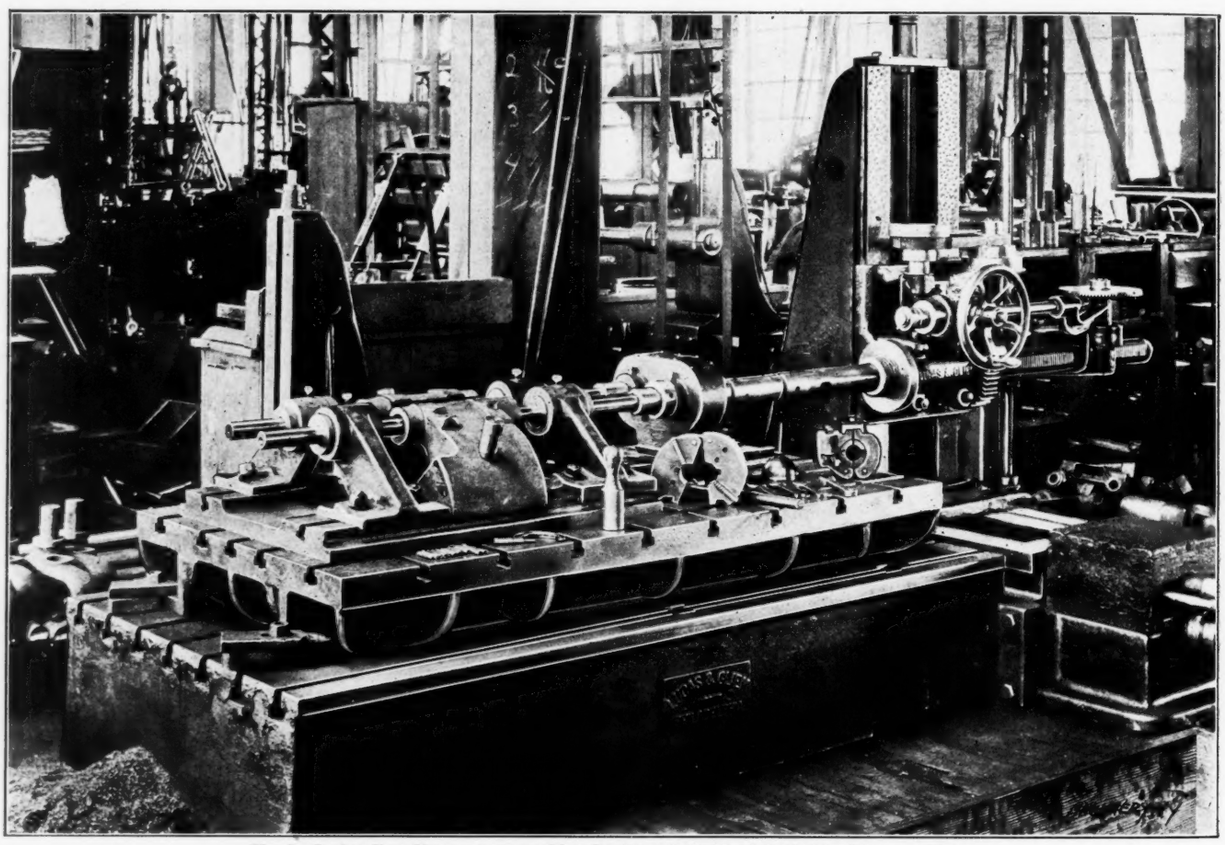


Fig. 2. Boring Two Pieces at once with a Double-spindle Head Guided by Ways on Fixture

the platen in Fig. 2. The body of this tool is composed of two members, *A* and *B*, bored to fit the bar and pivoted to connecting link *C*. The side opposite the link is machined with tapered lips as shown, to receive the binding clamp *D*. This is drawn down over the lips by a screw *E*, fitting in a

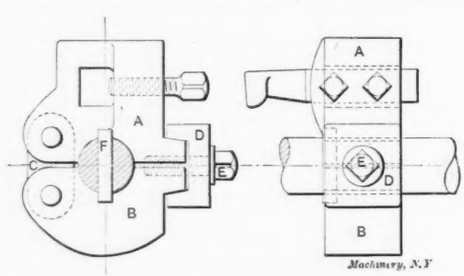


Fig. 3. A Simple and Convenient Split Boring-head

hole tapped into the split between *A* and *B*, being formed half in one member and half in the other. The combination of the screw and wedge action, it will be readily seen, gives a tremendous grip on the boring bar. The screw *E*, of course, fits into its hole loosely when *A* and *B* are tightened on the

first in history to prove successful. This is an obvious error. The welding of copper to other metals is a process that has been developed both in Europe and America. By this process, not only can steel be faced with copper, but also with aluminum and other metals that do not weld under ordinary conditions. At the present time the Westinghouse Machine Co. is using steam turbine buckets composed of a steel core and a copper jacket so intimately united that a piece can be drawn in a drawing die and reduced to whatever size and shape required. The metal is received by the Westinghouse Machine Co. in rods and bars and is drawn to shape in ordinary drawbenches. The copper and steel draw uniformly, the relative thickness of the two metals remaining practically the same even with great reduction of cross section area.

* * *

A press message was recently sent by the *New York Times* to the *Chicago Tribune* by means of wireless telegraphy from New York to Chicago. The difficulties involved in sending the message, owing to interference of currents, showed that wireless telegraphy in its present state is not a serious competitor of ordinary wire telegraphy for transmission of messages over land.

A REMARKABLE PROPELLER SHAFT REPAIR

F. E. S.

Did you ever work in a tool-room with one of those chaps who knows it all, who always will take the opposite side of any subject simply to argue, who always can cite without hesitation something that he has seen and done that makes the topic under discussion look like "thirty cents," who is never wrong, who will argue until cornered and then take the opposite side and swear up and down that this (the opposite side) was his point of view from the start of the argument, who will argue over the definition of a word and when the dictionary is produced to prove his argument wrong, will claim that Webster made a mistake? Well, we had one of these individuals in our tool-room, and it happened to fall to the lot of Davey, our apprentice, to actually "take a fall out of him," and he did it to the queen's taste. This "know-it-all" had traveled all over the United States and foreign countries. He had worked five years here and seven years there, was superintendent in Georgia three years, and so on. The total made his age to be about eighty-five years, according to his own tales. He was always able to mention incidents bearing on any subject that had come under his observation in this country or that, and was a veritable walking encyclopedia of wonderful experiences and observations.

One noon hour he was under exceptionally high pressure (hot air), and started off telling a thrilling tale of experience, assuming that all-important "big I and little you" air: "I tell you, boys, you do not have the mechanics to-day that we used to have. To-day the men in the shops cannot do what WE were obliged to learn when I was serving my apprenticeship. I remember one time when I was sailing from Africa to this country and when out about a week the propeller shaft broke clean straight across. We were in a sorry predicament. We did not have a lathe on board and, of

"Say, how did you get the right- and left-hand thread in that big nut?"

course, the ship drifted helplessly. After two days and no signs of a vessel to rescue us, we decided to do something to repair the shaft.

"The shaft was twelve inches diameter, and almost everybody on board had some crazy suggestion to make as to the best way to repair the break. Well, sir, there happened to be just *one* mechanic on board, and do you know how he repaired that shaft? Well, I will tell you in a few words. This mechanic took a piece of soft wire and wound it around the shaft in a helix, measuring off the right pitch from coil to coil and putting a drop of solder here and there to hold the wire in place. On the other part of the broken shaft he did the same, only making the helix left-hand instead of right-hand. Thus he laid out left- and right-hand threads on the broken ends.

"Now this mechanic was ready for operations and everybody crowded around wondering what he was going to do next. Giving two men a three-cornered file each he started them to work on the ends of the broken shaft, filing a thread guided by the wire that he had carefully wound around. It took just a day to file these threads, and then we secured the broken ends of the shaft with a big nut, and that shaft is working on that boat to-day!"

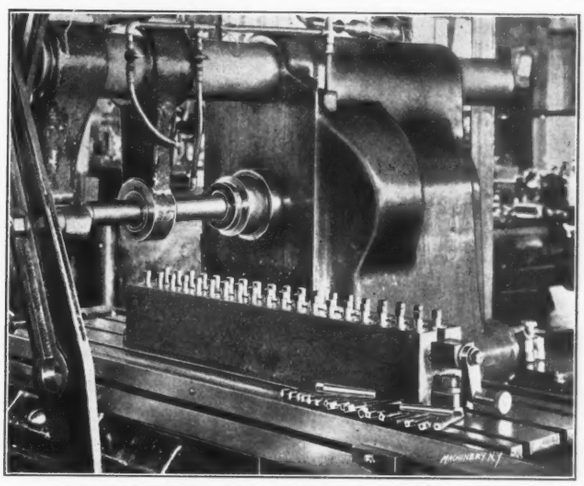
Davey, the apprentice, was first to speak, and he said, "Say, how did you get the right- and left-hand thread in that big nut?"

"Why," said one of the boys, "while the two men were filing the thread in the shaft, that wonderful mechanic was gnawing out the nut with his teeth!"

* * *

MULTIPLE INDEXING FIXTURE FOR MILLING SQUARE HEADS

The illustration shows a fixture designed for milling square heads on 38 screws or taper pins at one time. Each piece is held in an individual work-spindle, these being arranged in two rows as shown. The fixture, when filled with work, is fed past two sets of straddle mills on the cutter arbor of the



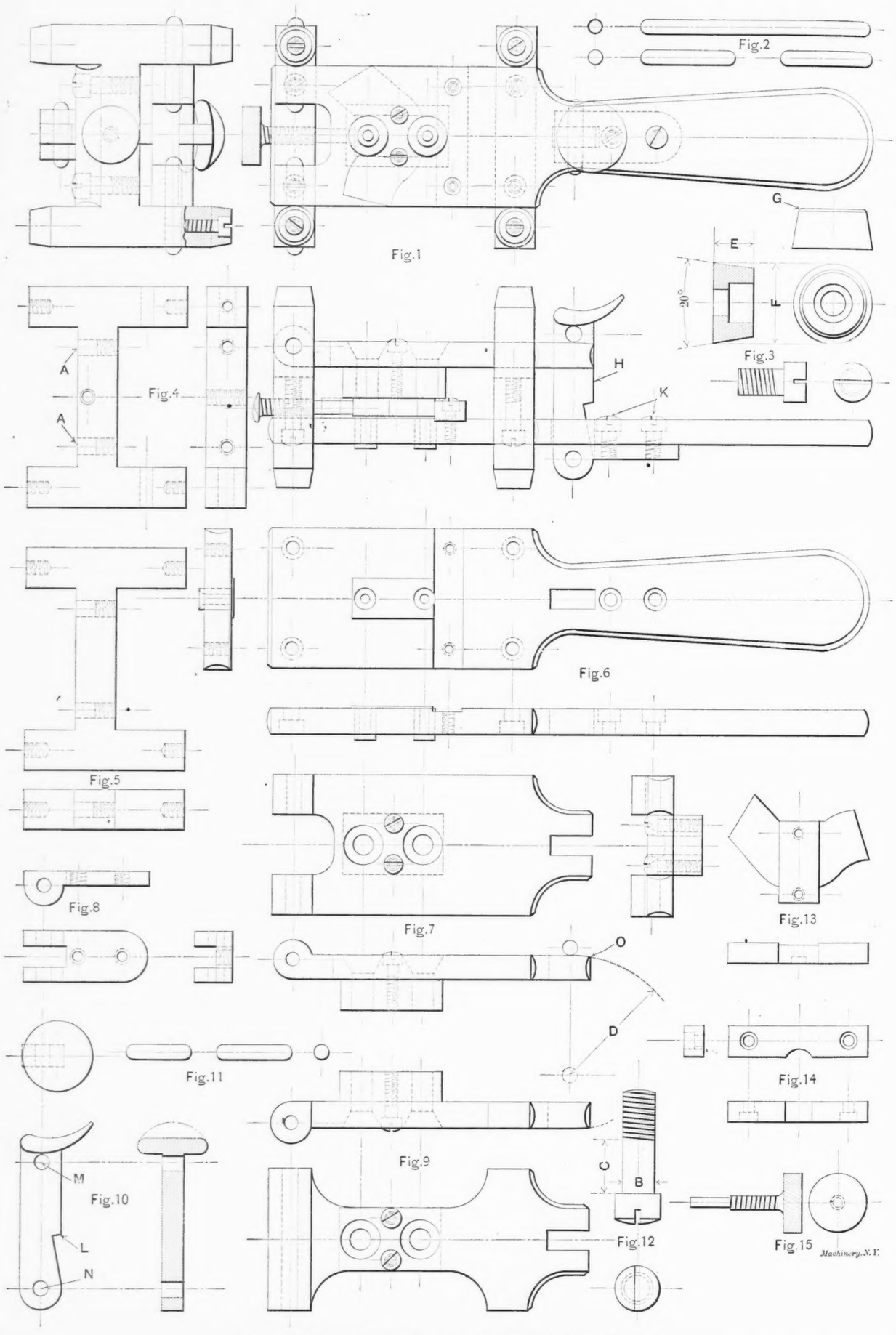
Fixture for Holding and Indexing simultaneously Taper Pins or Screws while Squaring the Heads

milling machine, which finish two sides of each head at one passage. By turning the crank shown at the end of the fixture, all the work-spindles are then indexed one quarter revolution, and fed past the cutters again, thus completing the square head.

The construction is very simple. Each work-spindle has keyed to its lower end a worm-wheel, meshing with a worm running the full length of the fixture, and connected with the crank handle shown. Six revolutions of the latter index the work spindles simultaneously one-quarter revolution. The crank handle has an index pin for locating it in a holder provided in the base of the fixture. Bushings in the work spindles are changed to agree with the parts to be squared. For taper pins simple taper bushings are provided, into which the pins are tapped firmly enough to hold them. After the heads have been squared they are easily removed with a small wrench. Collar screws are firmly screwed into tapped bushings. After the heads are squared they also are easily removed with a wrench. This fixture is in use in the shops of the Landis Tool Co., Waynesboro, Pa.

* * *

The advantages of small additions of vanadium in cast iron are referred to by Mr. J. Kent Smith in the *Foundry*. Small additions of about 0.2 per cent of vanadium are advocated, and examples are quoted showing the increase in tensile strength due to this addition. It also appears that the material does not become harder, but that the increase in strength is obtained without sacrifice of the ease of working the metal. It is mentioned that a locomotive valve bushing of vanadium cast iron which had been in heavy service for twenty-two months showed no signs of abrasive wear, and the original tool marks were still in evidence. A pair of chilled rolls having 0.22 per cent vanadium, showed a wearing life three times that of ordinary rolls made by the same firm without vanadium.

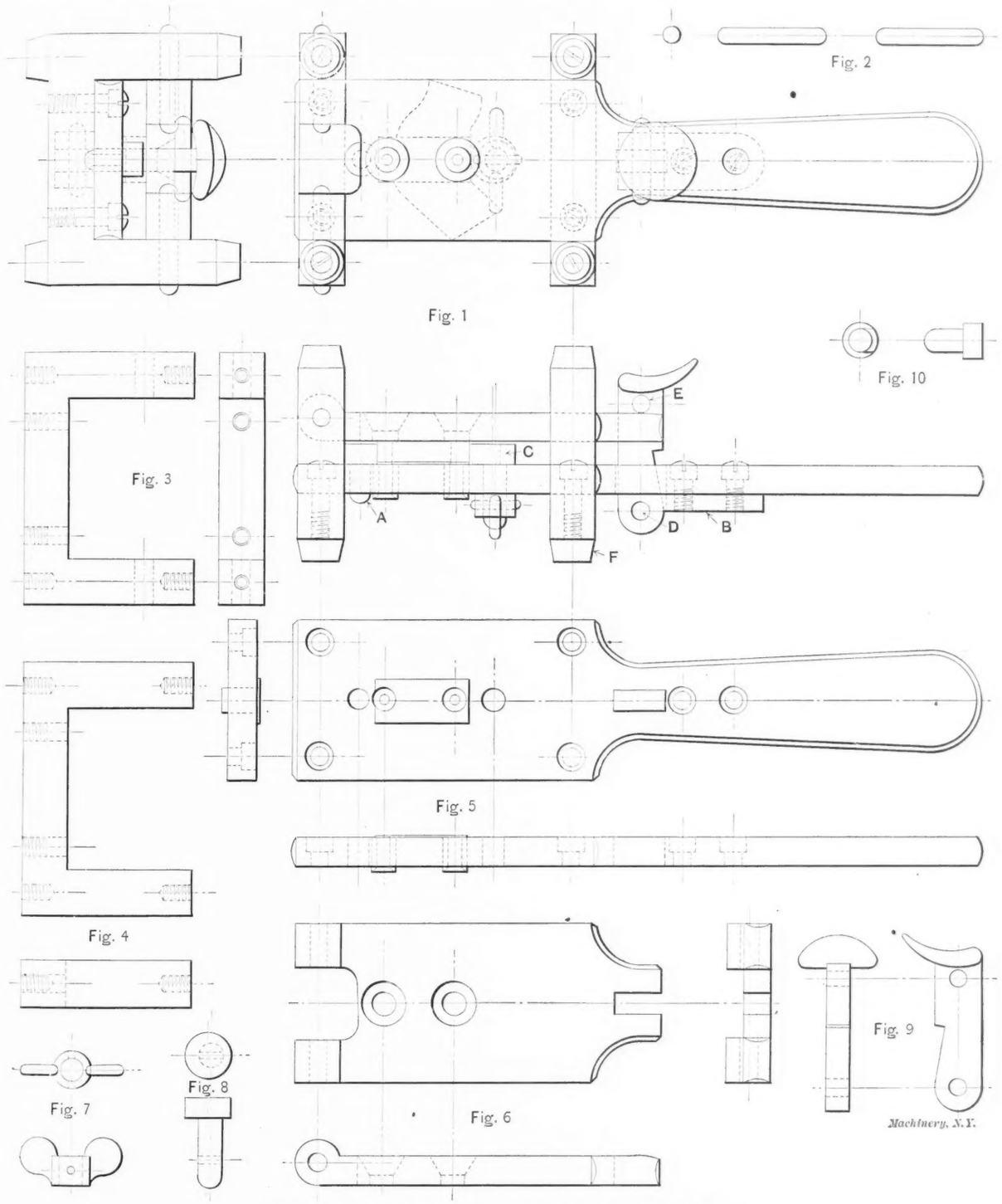


Standard Jig Design No. 1 for Manufacturing Small Interchangeable Parts

STANDARD DESIGNS OF JIGS AND FIXTURES FOR THE MANUFACTURE OF SMALL INTERCHANGEABLE PARTS—1*

FRANK P. CROSBY†

It is a fact well known to most tool designers and toolmakers that no two tool designers usually develop a special tool in the same manner. But little has been done in the way of standardizing the general outlines of jigs and the methods of clamping and locating the work. In the manufacture of large machinery, such standardization is difficult to secure, but in the case of small interchangeable parts it is possible to standardize the design of jigs and fixtures to a considerable extent. In the present series of articles the author will endeavor to show a number of examples of designs of jigs where most of the general features of the jigs are laid out according to a definite standard. The illustrations accompanying the articles will show the jigs referred to both assembled and in detail, and the experienced tool designer will find it more profitable to study the drawings directly than to have to follow a lengthy description of the devices. The descriptions will, therefore, be made as concise as possible, being confined to the most essential points.



Standard Jig Design No. 2 for Manufacturing Small Interchangeable Parts

Design No. 1

Design No. 1, shown in the accompanying full page illustration, is a drill jig for drilling and counterboring a needle bar

* The following articles on the subject of jigs and fixtures have previously been published in MACHINERY: Milling Fixtures, November, 1905, to February, 1906; Drill Jigs, November, 1906, to January, 1907; Jigs and Fixtures, April, 1908, to April, 1909. See also MACHINERY'S Reference Series No. 3, Drill Jigs; No. 4, Milling Fixtures; and Nos. 41, 42, and 43, Jigs and Fixtures.

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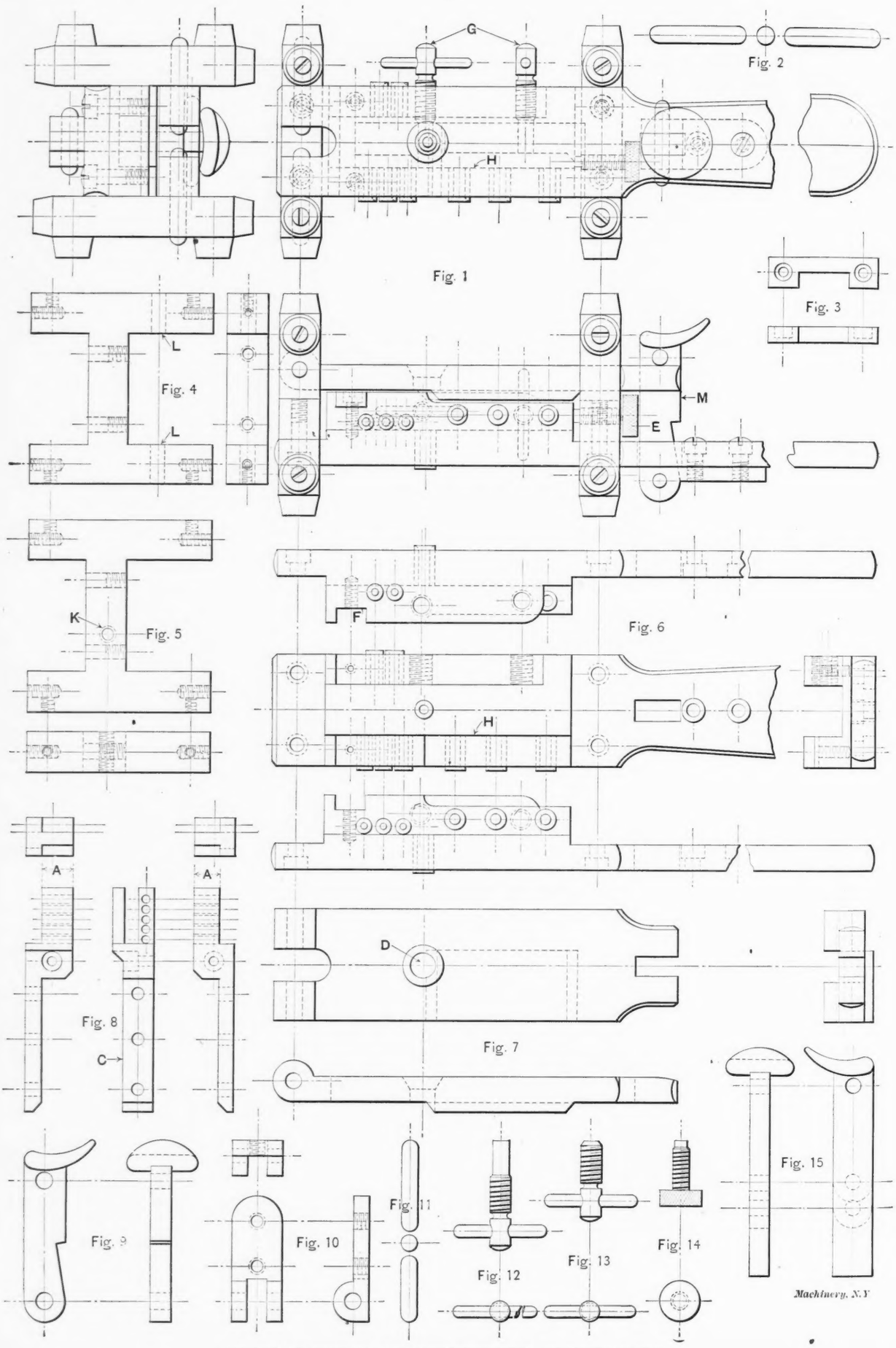

Standard Jig Design No. 3, for Manufacturing Small Interchangeable Parts

cam for a sewing machine, the cam being shown in detail in Fig. 13. It is required that the rivet holes in this cam be drilled and counterbored.

Fig. 1 shows a plan view, elevation and end view of the assembled jig. The jig is shown closed, ready for operation, with the work placed in position. Fig. 4 shows the standard H-shaped frame which can be employed for a great variety of small details of different shapes. The frame has holes tapped for the screws holding the feet, and is provided with the required drilled and tapped holes for the adjusting screw, the frame screws *A* and the hinge pin. The frame screw holes are reamed to a depth of one-half of the thickness of the frame cross-bar. Fig. 12 shows the frame screws in enlarged detail; the diameter at *B* should fit accurately the holes in the lower plate, Fig. 6, and also the reamed part of the holes in the frame, Fig. 4. By making the screws in this manner they serve the purpose of both screws and dowels. The dimension *C* of the screw, Fig. 12, should be a trifle less than the whole distance through the plate and one-half the distance through the frame, in order to permit the screw to bind properly. The diameter of the body part *B* of the screw is 0.005 inch larger than the outside of the threaded portion. The frame shown in Fig. 5 is an exact duplicate of that shown in Fig. 4, with the exception that no holes for the hinge pin and adjusting screw are here required. In Fig. 3 is shown an enlarged detail of the washers serving as feet for the jig, and also of the screws holding the washers to the jig. These parts are made of machine steel and case-hardened. The depth *E* is, on all sizes, made one-half of the diameter *F* and the corner *G* is chamfered to prevent scratching the drill press table. The counterbore in the washer is made a trifle deeper than the length of the screw head, to prevent the head from projecting outside of the counterbore.

Fig. 6 shows the lower plate, firmly held to the frames by the four frame screws already referred to. This plate contains the jig bushings which are shown in place. Fig. 7 shows the top or hinged plate, which is provided with a case-hardened bearing which holds the work against the lower plate by the pressure of the clamp latch *H*, Fig. 1. The arc with the radius *D* is struck from the center of the pin about which the clamp swivels. In Fig. 9 is shown a modification of the hinge plate. The construction is lighter, which in some cases is desirable. The plates are provided with ample clearance holes for drills and counterbores. In Fig. 2 are shown the hinge pins for both of the styles of upper plates. These pins are made from drill rod. In Fig. 8 is shown the latch holder which is attached to the bottom plate by two screws, as shown at *K* in Fig. 1. The latch itself is shown in Fig. 10. It has a notch cut at *L* to allow it to swivel so that its binding pin can clear the end *O* of the hinged plate. The latch can be made up as a standard part except for the pin hole *N*; the pin hole *M* only is drilled, and the hole *N* is left until the dimension from the center of *M* to *N* is known for any particular jig being made. This piece is case-hardened after it has been fitted. In Fig. 14 is shown the stop for the work which is attached to the lower plate and enters a slot in which it is held by two screws. In Fig. 15 is shown the adjusting screw which is also a standard detail. The pins in Fig. 11 are for the latch; these are made from drill rod and hardened.

Design No. 2

Design No. 2 shows a jig for drilling the same part as in Design No. 1, with a slight variation in details. Here also an assembled drawing consisting of plan view, elevation and end view, is shown. In this case both the upper and the lower plates of the jig are placed on the same side of the cross bar of the frame. This permits the plates to be set as close together as required for any piece of work to be drilled in this style of jig. Figs. 5 and 6 show the details of the lower and upper plates, respectively, and Figs. 3 and 4, the details of the frames. In Fig. 9 is shown the latch which is of the same kind as that shown in the Design No. 1. Fig. 7 is a wing nut with the threads removed and is also one of the standard parts used. In Fig. 8 is shown an eccentric cam which may be used in a great many different jigs, and which provides for a convenient means for clamping the work in place. This eccentric cam is turned by means of the wing nut, which is pinned to its stem as plainly indicated in Fig. 1. The stop shown in Fig. 10 is placed at the end of the work opposite the cam, and the work is held between this stop and the cam. The stops can be made standard. They should be made to the same dimensions as the screw heads so as to suit the holes made by the screw head counterbores. The other parts required for the jig, the hinge pins, Fig. 2, the pins *E* and *D* for the latch, as well as the bracket *B*, and the feet, are standard parts of the same dimensions as used in Design No. 1.

Design No. 3

The jig designated as Design No. 3 is used for drilling the two pieces shown in Fig. 8. The only difference between the two pieces is the variation of the width *A*. These pieces are drilled from three sides. In Fig. 1 is shown the assembled jig with the work in position, in Fig. 6 the lower plate with all the bushings in place, and in Fig. 7 the upper plate which is fitted with a projection which clamps the work on the side *C* in Fig. 8. The upper plate is also provided with a clearance hole at *D* for the counterbore. Fig. 3 shows the stop against which the work is held by the binding screw *E*. This stop is made from machine steel and case-hardened and fits into the recess shown at *F*, Fig. 6. The clamping screws *G*, Fig. 1, hold the work firmly against the wall *H*. In Figs. 4 and 5 the frames are shown; both of the frames are alike with the exception of the binding screw hole at *K* in Fig. 5 and the hinge pin holes at *L* in Fig. 4. The upper plate or leaf is held in position by the latch *M*, Fig. 1, which is shown in detail in Fig. 9. Figs. 12, 13, and 14 show the binding screws in detail. Fig. 15 shows the method of making up the standard latch for different jigs, the dotted lines indicating how the latch is finished to different lengths required.

General Remarks

Upon examination of the illustrations shown as Designs 1, 2 and 3, the tool designer will be surprised to find to how many small parts these general designs can be applied, and he will realize that with slight modifications, a variety of jigs can be made up from parts most of which can be kept in stock. The drawings have been made in the same manner as they would be made for shop use, with the exception that dimensions have been left off. Complete details are shown, as this is most essential to the proper making of the tools. It is a great mistake not to show the work in detail, as is sometimes the practice in jig and fixture work, because but little extra time is required in the drafting-room, and that time is more than made up for by the ease with which the tool-maker can understand the construction of the tool. The liability of mistakes is also largely eliminated and there is no need of verbal explanations as is otherwise often the case.

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LIGHT GASOLINE MOTORS

In the July, 1908, number of MACHINERY there appeared an illustrated description of the Adams-Farwell multiple-cylinder gasoline engine built for an aeroplane flying machine that is remarkable for extreme lightness. It has a capacity of 36 horse-power (figured by the A. L. A. M. rule) with a weight of only 97¼ pounds. The weight per horse-power, therefore, is only 2.7 pounds. To produce one horse-power or the equivalent of lifting 33,000 pounds 1 foot high in one minute with a dead weight of only 2.7 pounds was and is a most remarkable achievement. Whether the flying machine ever develops into a commercial possibility or not, the fact that experimental work on it has enabled us to develop power with such remarkably light engines, means much for many other businesses in which light motors are desirable. It is interesting to compare the weight of this motor per horse-power with the massive engines constructed in the time of James Watt. Then, and many years later, it was the common belief and practice that great weight was essential in large engines. The development of the marine engine did much to show the fallacy of this idea, and the later development of the automobile engine still further discredited it. The airship motor is the last word to date.

TRUING A BENCH LATHE BED

WALTER GRIBBEN*

The bed of the lathe that is much used naturally wears hollow just in front of the head-stock, and this is particularly the case with a bench lathe, as this type is used largely for chuck work. Such a lathe had been in almost constant use for nearly twenty years, so it was thought advisable to true up the bed. A cast iron templet of the shape shown in Fig. 1 was first made. The length of this templet was about two-thirds that of the lathe bed, and two V grooves were planed in it that were duplicates of the grooves in the bottom of the

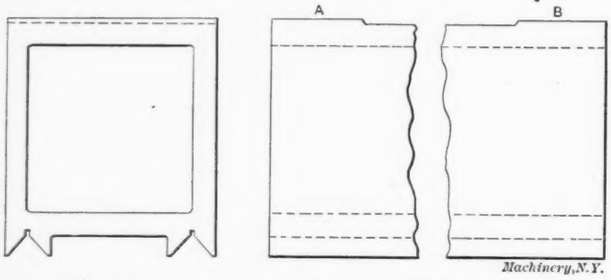

Fig. 1. Master Surface Plate used in Scraping the Ways of the Lathe Bed

tail-stock. The templet was made in the form shown so that it would resist bending or torsion, and yet not be very heavy.

The distance between the V's of the lathe bed was determined by means of a microscope held vertically in the slide rest as shown in Fig. 2. A brass block *A* was made with a V groove in the bottom to fit the V's on the lathe bed. On the top of this block two fine lines were scribed, one being parallel to the lathe bed, and the other at right angles to the first, but not quite touching it. This second line was to ensure the observations both being taken at the same part of the

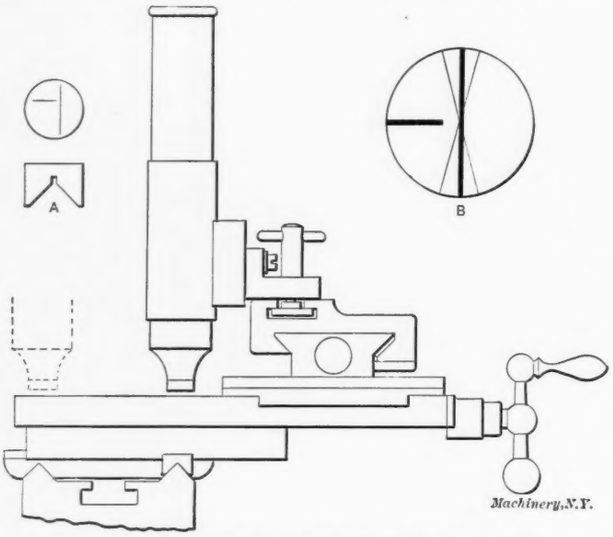

Fig. 2. Obtaining the Distance between the Ways by the Use of a Microscope

first line, in order to eliminate any error that might arise from want of parallelism between this line and the bed. The block *A* was first laid on the front V and the microscope sighted on the marks on its surface, which appeared through the microscope as shown at *B*. As indicated, the eye-piece of the microscope has cross lines arranged like the letter X. By adjusting the cross feed-screw and the block *A* along the bed, the intersection of these lines was made to coincide with one edge of the longitudinal line at a point opposite the transverse line. When the block and microscope were set, the reading of the cross feed micrometer was noted. The block was then placed on the back V of the lathe bed, after which the cross slide was moved until the intersection of the cross lines again coincided with the line on the block as before. The reading of the cross feed micrometer was again taken, and a comparison of the two readings noted, allowance being made for the number of complete turns that had taken place. By this method the distance between the V's from apex to apex was obtained. A gage with hardened and lapped ends was then made, of 5/16-inch drill rod, to exactly this dimension. This gage was enclosed in a wooden jacket as shown in the end view at *A*, Fig. 3, to prevent changes in its length from the heat due to handling. The lower side of the jacket, and also the side against which the strip *a* is screwed, were both made parallel to the length of the drill rod, so that when the enclosed gage was laid on the cross rail it would be parallel with the latter.

The templet casting was first placed on the planer in the position shown in Fig. 1, and the feet *A* and *B* planed. Care was taken not to clamp the casting down any tighter than was necessary during this operation. It was then turned over so that the planed surfaces rested on the platen to which red-lead had been applied in order to determine if both feet touched it throughout their entire area. This was found to be the case, so the V's of the templet were next planed. The dial indicator *B* was clamped to the cross rail of the planer

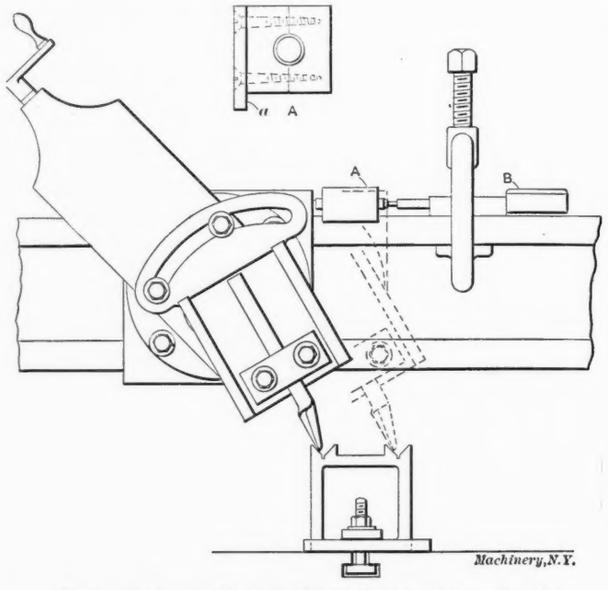

Fig. 3. Planing the V's in the Master Surface Plate or Templet

as shown in Fig. 3, and the saddle brought into contact with it while planing one V. The gage *A* was then interposed between the saddle and the indicator while planing the other V, the saddle being so adjusted for the finishing cuts that the indicator read the same in both cases. When the head was swung over to plane the other slope of the V's, of course the indicator had to be moved to a new position on the cross rail. The same scheme was also used to space the two positions of the parting tool that was used to cut out the bottom of the grooves, preliminary to planing the V's.

After finishing the planer work on the templet, it was tested with a spirit level both for wind and straightness. Two pieces of ⅜- by ⅝-inch rolled brass were drilled, tapped,

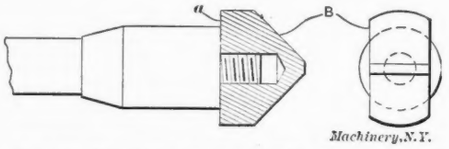

Fig. 4. Method of Machining the Small V-blocks used as indicated in Figs. 5 and 6

and the face *a* (Fig. 4) carefully turned at one chucking; these pieces were then screwed on the chuck. The finishing cuts for both pieces were taken with the same setting of the milling cutter so as to make them exact duplicates in regard to the location of the V-surfaces in relation to the faces *a*. The method of testing the templet for wind is shown in Figs. 5 and 6. The templet was supported on the bench by three leveling screws, *C* and *D* being at one end while *E* was at the other. The two brass pieces *B* were then laid in the V grooves near one end of the casting, and a ground spirit

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level laid on top of them as shown. The screws *C* and *D* were then adjusted until one end of the bubble coincided with one of the marks on the vial. Then the blocks *B* were moved to the other end of the casting, and the level applied as before. The bubble moved to the mark with which it coincided before, thus showing that there was no wind in the V's that could be detected with that particular level. It was not a precision level, but was a great deal better than the ordinary blown level. The vial was ground true on the inside, while the outside was marked transversely by lines about 1/10 inch apart, the curve of the vial being such that the travel of the bubble from one mark to the next represented a change in direction of the base, amounting to .012 inch per

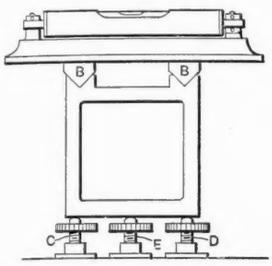


Fig. 5. Testing the Ways to see if they are in the same Horizontal Plane

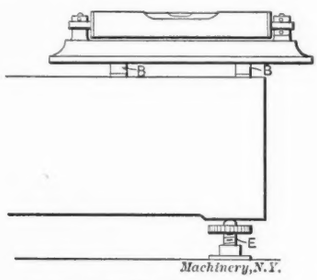


Fig. 6. Testing the Straightness of the Ways

foot. By using a magnifying glass, much smaller variations than this could be detected. As an accurate straight-edge of sufficient length was not available for testing the straightness of the V's, they were verified by using the spirit level and the blocks *B* as shown in Fig. 6. The blocks were first placed near one end of the casting, and the screw *E* adjusted until one end of the bubble coincided with one of the marks of the vial. The blocks and level were then moved to different positions along the length of the groove, and as the bubble remained in the same position, it was assumed that the planing was straight enough for the job in hand. In order to true up the V's of the lathe bed, a thin layer of Prussian blue was applied to the V grooves of the templet which was then moved along the bed to transfer the coloring matter to the parts that needed scraping down. After a sufficient amount of scraping, the V's on the bed showed a bearing throughout their entire length when the templet was applied.

* * *

Most of the penny-in-the-slot machines are worked by "victimized power"; that is, power derived from the patron or "victim." The patron furnishes the muscle that works the mechanism as well as the cent that releases the operating machinery. Strange to say, the element of action on the part of the user is an important factor in the success of some of these machines. It appears that many of the users of these machines enjoy pulling a lever; they somehow feel that they are getting more for their money than if they simply pressed an electric button. A certain fortune-telling machine was first put out with an electric motor driving the machinery. The patron only had to deposit his coin and place his hand on a slab in which there are many projecting studs to have his fortune told. The machine did not prove to be a "money puller." The motor was discarded and a long lever was substituted, which must be pulled each time a fortune is told. This machine yields a handsome income. The experience adds to our knowledge of the curious phases of human psychology.

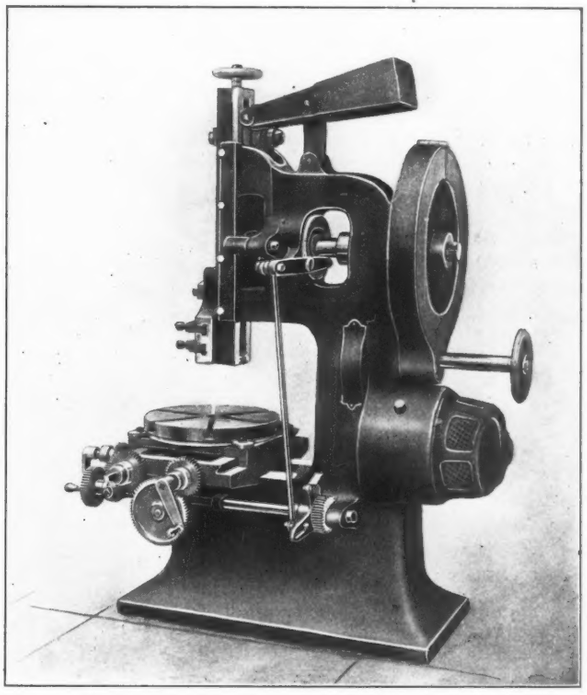
* * *

The "bleeding" of pine trees for their resin has generally been regarded as injurious to the timber, and in the specifications of many architects and railway companies, the "bled" timber is excluded. Investigations have been undertaken by the Forest Service of the United States Department of Agriculture in order to ascertain to what extent such timber is injured. The results of these tests indicate, however, that the "bled" timber is as strong as the "unbled" if of the same quality otherwise; that the weight and strength is not affected by the "bleeding"; and that the durability is the same of "bled" as "unbled" timber.

ENGLISH TYPE OF ELECTRICALLY-DRIVEN SLOTTER

JAMES VOSE*

The slotter illustrated herewith is one of the line built by John Stirk & Sons, Halifax, England. The distinctive feature of this machine is the motor drive which, as will be seen, forms an integral part of the design. Incidentally this feature has proved of value in an unexpected direction as under the revised tariff of one of the British colonies, if a motor forms an integral part of a machine, as in the present case, the duty on the electrical portion is on a lower scale than if the same size motor was applied as an attachment. The motor for this machine may be of the direct-current, constant-speed, shunt wound, or direct-current, variable-speed, interpolar type. The motor being built into the machine economizes space and adds to the rigidity of the design. The number of strokes arranged for varies from 20 to 60 per minute, a gear box being used in conjunction with the constant-speed motors. The length of the stroke ranges from 6 to 24 inches. The table diameter is 24 inches, and its longitudinal and transverse movements are 12 and 15 inches, respectively. The machine will take work up to 46½ inches in diameter on top of the table. Both longitudinal, transverse and rotary power feeds having a wide range, are provided. The size of machine shown is equipped with a 2½ H. P. motor. The complete weight of the slotter is approximately 5,500 pounds, and the price F. O. B. is $735.00.



Electrically-driven Slotter with a Motor which forms an Integral Part of the Machine

[There are doubtless advantages in having the motor an integral part of an electrically-driven machine, but it has been demonstrated by American machine tool builders, that what is gained in the way of compactness and rigidity is more than offset by the disadvantages of such design. In event the motor of a machine, of which it forms an integral part, is incapacitated by the burning out of an armature or otherwise, the machine will have to remain idle until repairs can be made, unless, as is not probable, the defective motor can be replaced by another. If, however, the machine were driven by a standard motor, which was simply bolted to the frame, the latter could easily be removed and replaced by another if necessary. In a shop where electrically-driven machines are in use, it is more than probable that such a motor would be available, and, consequently, it would not be necessary to keep a valuable tool idle.—EDITOR.]

* Address: 328 Moss Lane East, Manchester, England.

ROLL GROOVING MASTER TOOLS*

M. B. STAUFFER†

The method of making the master tools which are used to mill the cutting tools for grooving flour-mill rolls, is described in the following (since a large per cent of mill rolls are 9 inches in diameter, I shall treat that size tool):

The blanks are first made as shown in Fig. 1, the outside being rough turned. They are then gashed, as shown in Fig. 2, with the proper number of teeth, which ranges from eight to twelve. After keyseating the blank it is placed on the milling machine arbor in proper relation to the cam *D*, as shown in Fig. 3. It is desirable to have the cam operate as shown, as the tool will then be positively withdrawn from the work and interference will be avoided.

The circular attachment is placed on the milling machine table and set so that its center line coincides with the center of the blank *A*.

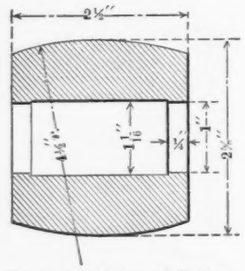


Fig. 1. Rough-turned Cutter Blank

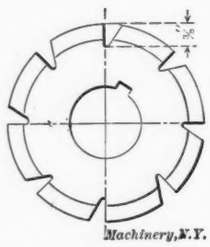


Fig. 2. End View of the Gashed Blank

On the circular attachment is placed the auxiliary tool slide *B* which should be arranged with a positive stop. For the finishing cut, the point of the turning tool must be 4½ inches from the center of the attachment. The feed screw nut must be disengaged from the feed screw and a spring or weight attached to the table to keep the stop *C* against cam *D*. The tool should be set to the same height as the center of the arbor.

We are now ready to proceed with the finish turning and simultaneous relieving of the lands. After turning the blank, the tool shown in Fig. 6 is inserted in the slide. This tool

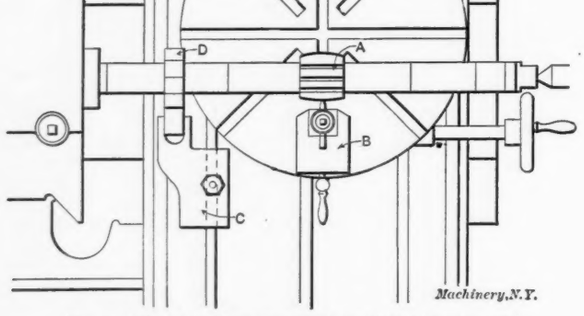
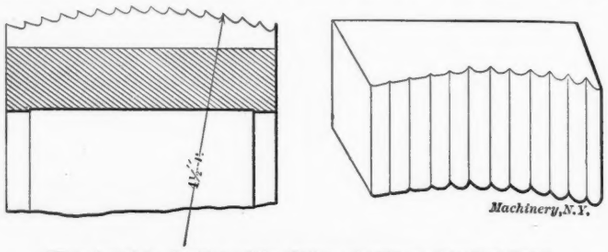


Fig. 3. Milling Machine arranged for Finish Turning and Serrating the Cutter

must have enough clearance to allow for the advance of the cam. The first serration should be to the full depth, as shown in Fig. 4, and the positive stop should then be set. It will be understood that when the tool just touches the blank it must be 4½ inches from the center of the attachment. The indexing is done by use of the dial on the hand-wheel shaft of the circular attachment. It is imperative that the indexing be accurate or the cutting tools will not work well and may break the corrugations on the rolls.

The depth of the serrations depends entirely on the style of corrugation. The one shown is commonly called the "saw tooth" corrugation and is 1/16 inch deep when standard, having 1/6 inch pitch.

The clearance will not be ideal but near enough for all practical purposes. The tools will be superior to the old style tools which were made without clearance, and which burnished the metal into shape instead of cutting it. When finished, the cutters look like the one shown in section, Fig. 4.



Figs. 4 and 5. Section of the Cutter, showing a Serrated Tooth, and One of the Grooving Tools

A convex cutter without serrations will be found very useful for milling the cutting tools, Fig. 5, concave. The cutters may be hardened in oil and need not be drawn to more than 400 degrees Fahrenheit. They must be carefully handled and should be used only on well-annealed stock, or the sharp points will be quickly destroyed.

* * *

A BALL-BEARING WORM

Some years ago there was described in the various technical papers a ball-bearing nut, designed by the Sprague Elevator Co. for use in passenger elevators. A helical row of balls was interposed between the threads of the nut and those of the screw, to receive the thrust of the load. A suitable transferring tube led the balls from the top of the nut back to the

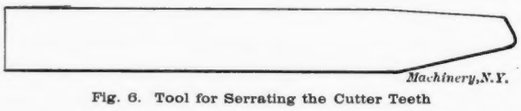
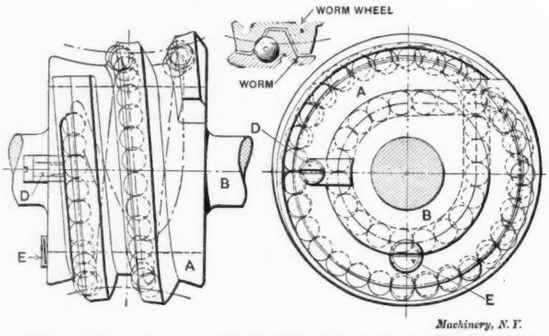


Fig. 6. Tool for Serrating the Cutter Teeth

bottom (or *vice versa*) where they again entered the space between the nut and the screw. The balls thus followed through their path in a continuous stream furnishing a rolling contact between the screw and the nut to take the pressure of the load.

In the accompanying illustration, taken from *Le Genie Civil*, is shown a worm which is a counterpart of the Sprague Elevator screw. The acting face of this worm is channeled to form a race for an endless row of hardened steel balls, which are led at one end of the thread through an internal return duct, re-entering the race again at the other end of the thread. The construction is plainly shown in the engraving.

The worm is of the globoid or Hindley type, with a concave or "hour-glass" shape. The threads are cut on a shell *A*, which is mounted on a body *B*, to which it is held by screw *E*



A Worm whose Contact with the Wheel is made on Ball Bearings

which prevents it from moving and thus as well from turning. A channel of such shape as to retain the balls is cut in the acting face of the worm. A corresponding reversed helical groove is cut in the periphery of the body *B* to lead the balls back again, suitable connecting holes being drilled between the grooves in *B* and those in the teeth in *A*. The channel is filled full of balls through an opening, closed by a cover and screw at *D*.

* For additional information on this subject, see MACHINERY, May, 1909, "Grooving Chilled Flour Mill Rolls," and June, 1906, "Roll Corrugating Device."

† Address: Scottdale, Pa.

This ball bearing worm is built on what is known as the Système Parrouff et Arlaud. The scheme is interesting, but it appears that there would be a sliding movement in a direction radial to the axis of the worm which the ball bearing will not take care of. It must be admitted, however, that the construction shows great ingenuity.

* * *

AUTOMATIC MILLING MACHINE ATTACHMENT FOR MANUFACTURING INTERNAL GEARS

In the *Zeitschrift des Vereines deutscher Ingenieure* of March 20, 1909, is described a slotting attachment for the milling machine, particularly adapted to cutting the teeth of

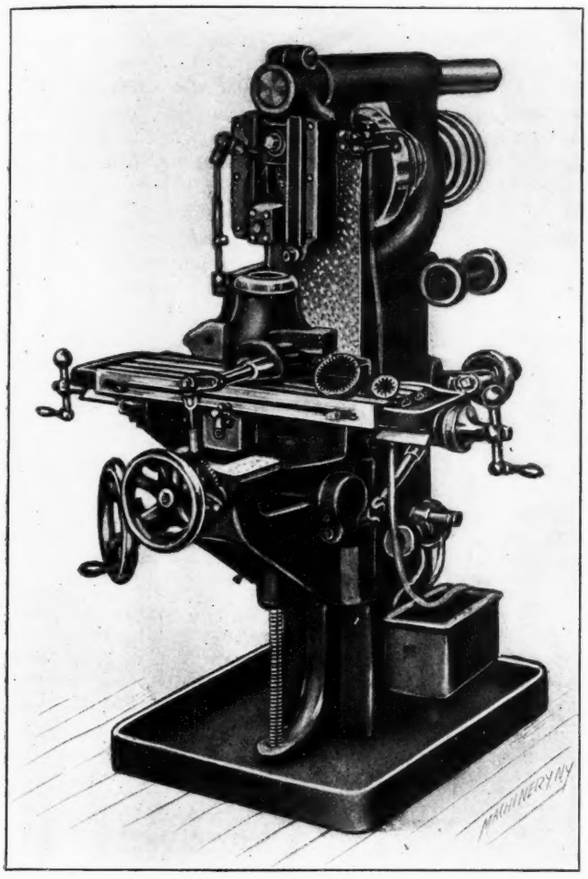


Fig. 1. Slotting Attachment to Milling Machine for Cutting Internal Gears in Quantities

internal gears, and for doing internal slotting in general which requires the indexing of the work. Fig. 1 shows the attachment applied to a milling machine, while Fig. 2 gives the details of its construction.

This device consists of two parts—the slotting attachment proper, and the work holding and indexing device. The slotting attachment consists of a ram *A*, which slides in ways in the body of the device, and is driven by a crank-pin attached to the milling machine spindle. The length of stroke is adjustable. The body of the device is fastened to the supporting arm of the milling machine, and is screwed to the column as well, to prevent motion sideways. The work *M* is gripped in a chuck *H*, bored to receive it, and held by dowel pins and screws to the spindle *S*. The work is indexed at each stroke of the tool on the up movement of the ram. This is effected by stud *B* on the ram *A*, operating through the connections *C* and *D*. The vertical plunger *E* has rack teeth cut in it, engaging the teeth in the gear *F*, which in turn meshes with pinion *G*. The latter engages the rack teeth of the horizontal plunger *I* and is thus moved positively forward at the end of the up stroke of the tool. It is drawn back again by the spindle as soon as the tool slides forward to descend. Connection is made by the rack *I* and a lock bolt *N*, so that the latter is withdrawn as *I* moves forward, leaving locking wheel *L* and index ratchet *K* free to revolve the work spindle and the work. A dog on rack *I* engages a stop, not visible in the illustration, which turns the index ratchet *K* and at the same time the chuck *H* and the work. At the conclusion of the movement locking bolt *N*, under pressure of spring *P*, slides back, locking the spindle and the work in the new position. Lock disk *L* and ratchet *K* must have the same number of teeth as the gear to be cut.

When a complete revolution of the work has been made by the means described, the saddle is moved outward slightly along the slide, thus setting the work for a new cut. This is effected by lever *W*, shown in dotted lines, which is pressed upward by dog *R* on a plate keyed to the spindle. By this means, through rod *V*, the arm *U* is operated, and the ratchet wheel turns the cross feed screw slightly, thus setting the work to depth for a new cut. Adjustable dog *T* limits the amount of feed. Provision is made throughout this attachment, by adjustable connecting rods and universal joints, for setting the machine up for work of widely varying dimensions.

This method of cutting internal gears has some advantages over the method of cutting them with an internal attachment in the automatic gear cutter. The drive for the cutter by the latter method is far from satisfactory, and it is necessary always to provide in the work a large clearance space for the cutters to run out into. Using the slotting attachment shown herewith, a narrow groove will suffice to give clearance. The indexing of the work at every stroke, and the provision for stopping the feed when the proper depth of cut

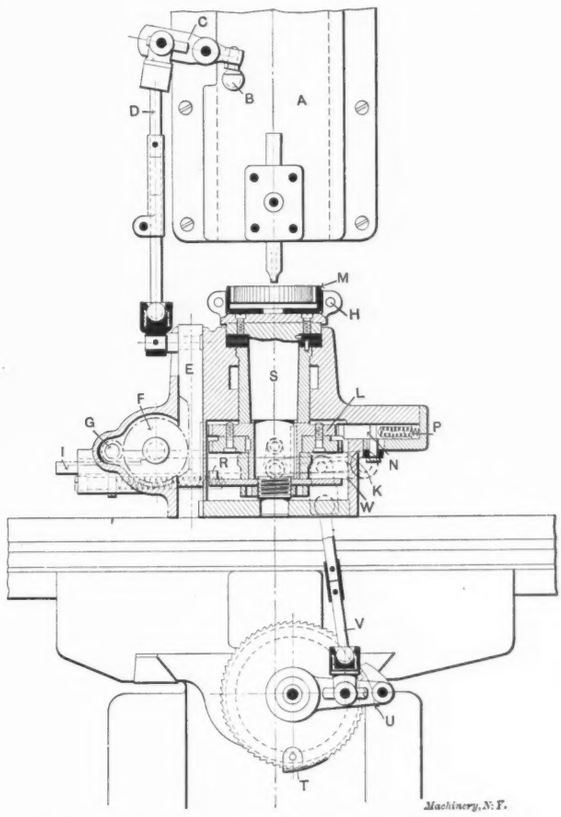


Fig. 2. The Mechanism of the Automatic Slotting Device for Internal Gears

has been reached, make the device automatic, so that the operator is free to attend to other work. There remains only the necessity for occasionally cleaning the work of chips, where the clearance space provided is unusually small.

* * *

The total exports of machine tools from Germany in 1908 amounted to 58,522 metric tons, and the total imports in the same year to 5,843 tons. The exports increased by 500 tons, while the imports decreased by 2,300 tons, from the previous year. Germany's best customer for machine tools is Italy, with Austria-Hungary a close second. France, Belgium and Russia also take a great deal of their machine tool supply from Germany. Of the imports of machine tools, more than 50 per cent came from the United States.

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LIMITATION OF MACHINE CAPACITY

The improvement in machine tool capacity during the last few years, since the introduction of high-speed steel, apparently has brought designers in sight of the ultimate limit of profitable capacity on certain machines which require manual operation. When the efficiency of the machine reaches the point where the handling of the product to and from it requires as much time as the actual operation, the opportunity for profitable increase of mechanical efficiency has become small, and it soon vanishes beyond that point. Further gain can only be made by dispensing with the operator, making the machine automatic, and the moment this is done an entirely new set of conditions is created.

To illustrate the point, take the case of high-speed drilling. Several months ago we referred to a drilling machine that on test had make the remarkable record of drilling cast iron with a 1¼-inch high-speed drill at the rate of 29 inches per minute. So rapid was the downward travel of the spindle that it was necessary to set the feed throw-out stops before starting in order to prevent drilling into the platen underneath, even when the work was raised an inch above it! Suppose this piece had four holes, 4 inches deep, to be drilled. Then the actual drilling time required would be, say, 34 seconds. The time for lifting the casting upon the machine, adjusting the drill to the drilling positions and its removal would be, say, one minute, the best that could be done. That is, the handling time is nearly double the drilling time, and the actual drilling time bears a smaller and smaller relation to the handling time as the mechanical efficiency is increased, soon becoming so small a fraction of the operator's time after even time is passed, as to make further increase of mechanical efficiency unprofitable.

In the case of driving-wheel lathes, the production has reached the figure that makes the labor cost of handling the wheels greater than the operator's wages. Further improvement must be in the direction of reducing this labor cost, or, to put it more plainly, after a certain degree of mechanical efficiency is attained, it becomes more profitable to make further improvements outside the machine to reduce the labor and time of handling the material by devising extraordinary means for handling the work with speed. There is, however, the possibility of so highly developing a machine and its attendant features as to throw the shop out of balance because of lack of coordination of other departments. Often in such cases the highly developed machine cannot be profitable to the shop until the other parts are brought up somewhere near the leader's productiveness. There is the fact to be considered in all cases, that greatly increasing mechanical efficiency means a large increase of investment and consequent interest and depreciation charges. These at some point become so great that further increase of labor-saving capacity is actually unprofitable.

* * *

HIGH-GRADE STEEL FOR STAYBOLTS

The recommendation of Mr. H. B. Wille in his American Society of Mechanical Engineers paper, "A New Departure in Flexible Staybolts," to use small diameter spring steel stem staybolts instead of the large diameter iron bolts commonly used, is one that should receive the attention of locomotive builders and all concerned with the difficult problem of locomotive boiler upkeep.

It is evident to anyone who has studied the problem that the iron staybolt cannot withstand the severe service imposed on it, because the elastic limit of the material is constantly being exceeded. There apparently is no practical way to avoid it, notwithstanding the activity of inventors of flexible staybolts. The difference in temperature between the outer and inner plates of the firebox section of the boiler may sometimes be 300 degrees F. or more. Using the proper coefficient of expansion, a simple calculation shows that the deflection of two adjacent staybolts four inches apart is $0.0000066 \times 300 \times 4 = 0.0079$ inch total movement, which, equalized on two bolts, makes 0.00395 inch movement imposed on each staybolt perhaps only four inches in length, or less, rigidly secured in opposite plates. Often the total movement of the inner plate is all in one direction, thus throwing the total deflection on each. Experiments have shown that the best one-inch iron staybolt subjected to the vibratory test, wherein one end is rigidly secured and the other is revolved at the end of a radius of 3/32 inch and under a tension load of 4,000 pounds, breaks with about 6,000 vibrations.

It is no wonder then that staybolt breakage is a common trouble in locomotive boilers. The elastic limit of the material is exceeded whenever a boiler is cooled off for washing or repairs, and doubtless many times every day under heavy steaming. Observation has shown that the fire-box sheets are in continuous motion relative to the outer sheets, because of the varying temperature.

The recommendation to use spring steel stems with soft ends that can be riveted over, appears to be a common-sense solution of the problem. These bolts with 7/16-inch stems have a tensile strength of 32,000 pounds, and withstand vibratory tests of 500,000 to 1,000,000 vibrations.

Steel of high elastic limit and tensile strength can be used in many places where no other material will be successful. The automobile has shown constructors and designers the need of such materials, and the growth of the use of high-grade alloy steel as a consequence is one of the best evidences of increasing expert metallurgical knowledge and production. In steam engine construction, the use of spring steel piston rods and connecting-rods would undoubtedly lessen failures, balancing troubles, friction, and to some extent, condensation of steam on the piston rods because of reduced diameter.

* * *

Realizing the importance of water power, the United States probably will withdraw some of the land under public domain on which are valuable water power sites. Mr. George O. Smith, director of the United States Geological Survey, has recommended to the Secretary of the Interior that 236,365 acres of public land be withdrawn which are located in Utah, Colorado, Wyoming, Montana, Idaho, and Oregon. Various powerful corporations have been acquiring valuable water powers in the west with a view of monopolizing these natural power privileges which with the development of long distance transmission, have acquired in recent years values almost undreamed of a generation ago.

THE PRESERVATION OF IRON AND STEEL

The present age of iron and steel is one of great waste, particularly of so-called permanent structures, because of the rapid deteriorating effect of rust. The great problem for the metallurgical engineer is to find some means for protecting iron and steel from the corrosive tooth of time. Our great steel bridges, instead of being permanent, are rapidly decaying, as no satisfactory means have been found to stop the insidious action of rust. In great cities, particularly in Pittsburg, may be seen buildings sheathed with sheet steel in an advanced state of rust, great holes having appeared in roofs and sides. A few years more of decay will cause the buildings to tumble into ruins. It is a startling fact that the durability of wooden and steel structures is in favor of the wooden structures, barring the liability of the latter to be destroyed by fire. A paper on the preservation of iron and steel was read by Mr. Allerton S. Cushman before the British Iron and Steel Institute, in which the importance of the subject was impressively worded, and we quote from it as follows:

"Increasing consumption of the world's supply, and constant decay of materials menace the future of the human race. It is evident that carbon from which we derive energy, and iron which provides the possible means of providing energy are the materials which should particularly engage the attention of those who are studying the problems of conservation. The annual production of pig iron in the United States alone grew from 13,789,242 tons in 1900 to 25,307,191 tons in 1906, and while for the year of 1908, owing to industrial conditions, it decreased to about 16,000,000 tons, it seems sure to again show an increase in the near future. How much of this enormous and constantly increasing world's product of iron and steel is wasted for the lack of adequate preservation? Where will the growth of the demand stop, and how many years will the world's ore supply stand the drain upon it? These questions are of vast importance, and the answers can only be vaguely guessed. One thing seems certain: civilization must learn to conserve more efficiently its store of iron and steel already manufactured, and seek methods of preventing the almost resistless tendency of iron to return to its union with oxygen from which it was won only by the vast consumption of quantities of the fast dwindling coal supply. It is not generally realized that about four tons of coal or its equivalent is used for making one ton of finished steel from the ore. If steel could be by any means whatsoever ennobled, and thus protected from decay due to corrosion, future conditions for all years to come could be viewed with complacency. There exists in Delhi, India, an iron monument that since the beginning of history has been exposed to the weather without the result of decay, and yet this column has been provided with no protective coating other than that which the atmosphere has itself formed upon it. It is probable that with all our boasted knowledge we could not build its like. Yet the art is not necessarily lost forever. It is simply a case of whether or not it is worth our while to rediscover it."

* * *

THE MORSE DRILL TAPER SHANK TANG

The number of methods of restoring broken tang twist drills to a new period of usefulness that have been devised within the last few years is good evidence, though none was required, of inherent weakness in the Morse taper shank. The tangs on the large sizes of drills cannot long withstand the heavy torsional stress imposed by the powerful drilling machines of the present time, and large numbers of drills are damaged by twisting off the tangs in heavy drilling. The need of means for restoring such damaged drills to service has been commonly felt, but notwithstanding the fact that hundreds of concerns were throwing thousands of drills away as scrap, practical methods were not provided to check the waste until lately.

The weakness of the Morse shank made so apparent in recent years emphasizes the great advance made in the power of the present-day machine tools. Years ago when the Morse twist drills with taper shanks were brought out, machine tools rarely had sufficient power to twist off the tangs of drills in regular work, such accidents being the exception rather than the rule. If tangs were twisted off the fault was generally in poorly-fitted shanks and defective collets. The use of machine steel for collets was productive of a large number of failures of this character, and probably defective collets are largely responsible for damaged drill shanks now, but in the rush of modern manufacturing, it seems practically impossible to keep all drill press equipment always up to the mark. The enlarged tang and other means for increasing the torsional strength of the twist drill shank have come as a matter of necessity.

The manufacturers of machine tools and of twist drills should agree on a set of new standard drill shanks with enlarged tangs, and while conferring on this matter, they will find the time opportune to consider the advantages of the "Jarno" taper of 0.600-inch taper to the foot, over the mixed common tapers of approximately $\frac{5}{8}$ inch per foot. But, while the manufacturers are influential in bringing about needed changes of this nature, the users are to be reckoned with; and their present equipments are a formidable obstacle to a common standard, no matter how advantageous it may be. A change in tapers and tangs can be brought about only by concerted action of the leading makers and users, and no doubt even then it will be slow.

* * *

CORPORATION TAXATION

At the annual banquet of the Ilion Board of Trade, Ilion, N. Y., Mr. Fred J. Miller, assistant to the president of the Union Typewriter Co., New York, spoke on "Corporation Taxation" in part as follows:

"Without having especially looked into the matter, I take it for granted that Ilion has encouraged the growth of manufactures within her boundaries; that she has endeavored in all proper ways to encourage those of her citizens who have endeavored to do things calculated to build up and develop the town, and one of these ways is by the proper handling of taxation. In these days taxation of industrial enterprises is attracting a good deal of attention, and with your permission we will consider briefly some of the things which a community can do, by means of taxation, to encourage manufacturing enterprises.

"It ought to be obvious that a town which aims to grow should encourage as much as possible those things which cause growth, and discourage as much as possible those things which retard growth; to encourage the workers—the doers of beneficial things, and to discourage drones or those whose influence is adverse to healthy growth. This can be done by means of taxation. We often hear of towns which offer, as an inducement for the location of new manufacturing establishments, exemption from taxation for a term of years. This is, however, sometimes objected to by already established industries, especially when engaged in the same line of business, and which are often taxed heavily—I think properly objected to.

"Taxation, it seems to me, should not be levied upon the commonly accepted, but nevertheless socialistic principle, that the amount paid should be in proportion to ability to pay, but should rather be levied in proportion to the direct pecuniary benefits received by the taxpayer from the community or from the governmental organization for the support of which taxes are collected. In too many communities the opposite course is followed with the result that those who are doing most to build up the town are the most heavily fined for doing it, while those who are doing nothing to build up, but are reaping the pecuniary benefits of others' efforts, are most lightly touched by taxation.

"Such is the effect of levying comparatively heavy taxes upon factories and their equipment, upon business buildings and the goods within them, and upon the houses and furniture of citizens, while at the same time levying taxes proportionately much lighter upon vacant lots and unutilized land which is being merely held at prices that more or less completely anticipate future development and the demands of population.

"Let me not be misunderstood. I refer in a general way to the principles that should govern in a town which wishes to grow, and call attention to the fact that by assessment and taxation those things which do most to build up a town can be discouraged or encouraged, and that those things which do most to retard its growth can also be discouraged or encouraged."

The principle of promoting manufacturing industries by equitable distribution of the tax burden, making the land the basis for all assessments, is one of undeniable importance to manufacturers wherever located, and we think that whatever be their politics or creed, practically all will agree with Mr. Miller's sentiments, even though the basic idea is the fundamental one of the Henry George single tax theory.

* * *

The experiments undertaken by the Pennsylvania Railroad with concrete telegraph poles have been so successful that an increase is to be made in the use of these poles on the company's lines.

A NEW DEPARTURE IN FLEXIBLE STAY-BOLTS*

There is practically no literature on the subject of stay-bolts, and in particular, none on flexible stay-bolts. The increasing size and pressure of boilers make this subject of vital importance to railroads and to those responsible for the management of that type of boiler in which the firebox is stayed by a large number of bolts. The boiler of the consolidation

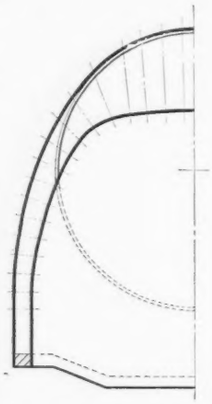

Fig. 1. Section of Firebox, showing Center-lines of Stay-bolts

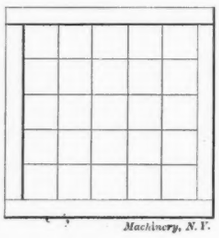

Fig. 2. Faggott Piling of Iron for Stay-bolts

locomotive, now the prevailing type in freight service, contains about 1,000 bolts less than 8 inches long and about 300 of greater length. The large types of Mallet compound locomotives now meeting with much favor have a much larger number, there being 1,250 short and 300 long bolts in locomotives recently constructed.

In recent years some form of flexible stay-bolt, that is, one having a movable joint, has been very extensively used in the breaking zone of locomotive boilers, but their high cost and the difficulty of applying them, the binding at the joint caused by rust and scale, and the fact that their use throws an additional service on the adjacent bolts because of lost motion, has militated against their more general use.

It is well known that stay-bolts fail, not because of the tensional loads upon them, but from flexural stresses induced by the vibration resulting from the greater expansion of the firebox sheets than of the outside sheets, but notwithstanding

Fig. 3. Flexible Spring Steel Stay-bolt

the general acceptance of this theory, engineers have designed stay-bolts solely with respect to the tensional loads. It is quite general practice, it is true, to recess the bolts below the base of the thread, and this has effected a slight reduction in the fiber stress, but practically no effort has been made to design a bolt to meet the flexural stresses or even to calculate their magnitude. This is surprising in view of the simplicity of the calculations to which the ordinary formulas for flexure apply.

Let F = fiber stress,
E = modulus of elasticity,
I = moment of inertia,
D = diameter of bolt,
N = deflection,
L = length of bolt between sheets,
W = load.

We then have $W = \frac{2FI}{DL}$ (1)

$$N = \frac{WL^3}{3EI} \quad (2)$$

Substituting W in (1) in equation (2) we have

$$N = \frac{2FL^2}{3ED} \quad (3)$$

$$F = \frac{3EDN}{2L^2} \quad (4)$$

This formula shows that the stress increases in direct proportion to the diameter and decreases as the square of the distance between the sheets.

The application of the formula to service conditions gives the following stresses:

Conditions: Bolt spacing, 4-inch centers.
Assumed expansion, 0.04 inch.
Length of bolt, 6 inches.

Type	Diameter of Bolt	Flexural Stress
Iron	1⅛ inch	51,500
Iron	1 inch	45,000
Iron	⅞ inch	39,400
Spring steel	1-inch ends, 7/16-inch stem	19,700

Iron is universally employed in the manufacture of these bolts and it is not good practice to exceed a fiber stress of 12,000 pounds per square inch. It is apparent that stay-bolts in the zone which meets the expansion of the sheets are stressed above the elastic limit and must necessarily fail from fatigue. Fractures always originate at the outside sheet at the point where the bending moment due to the movement of the furnace sheets is greatest. The fractures usually

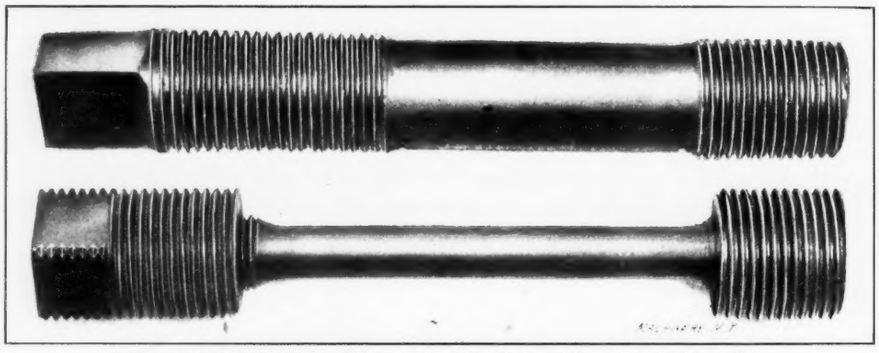

Fig. 4. Spring Flexible and Regular Iron Stay-bolts of Same Tensile Strength

start from the base of a thread and gradually extend inward. Manufacturers of stay-bolt material have endeavored to minimize failures and to meet the unusual conditions of an iron stressed beyond its elastic limit by the supply of specially piled iron arranged with a view to breaking up the extension of the initial fracture. For this reason iron piled with a central section of small bars and an envelop of flat plates has met with much success for this class of service. In a further effort to secure an iron specially adapted to this class of work various forms of shock, vibratory and fatigue tests have been imposed. No design has yet been produced, however, which permits the employment of material of elastic limit sufficiently high to resist the flexural stresses, although a large class of material particularly adapted to the purpose is available. It is obvious that the remedy does not lie in the use of a slow-breaking material, but in the employment of material of sufficiently high elastic limit to meet the conditions of service. It is also possible to reduce the diameter of the bolt greatly by the use of such a material, thus proportionately reducing the fiber stress in flexure.

Stay-bolt material, however, must possess sufficient ductility to enable the ends to be readily hammered over to make a steam-tight joint and to afford additional security against pulling through the sheets. To meet these conditions the bolt illustrated in Fig. 3 has been designed. The stem is of the same grade of steel as that used in the manufacture of springs. It is oil-tempered and will safely stand a fiber stress of 100,000 pounds per square inch. Its high elastic limit makes

* Abstract of paper by Mr. H. V. Wille, read before the May meeting of the American Society of Mechanical Engineers, at Washington, D. C.

it possible to reduce the diameter to 3/8 or 7/16 inch or even less. The ends are of soft steel, and it is thus possible to apply and head up the bolt in the usual manner.

The employment of a stem of the diameter indicated reduces the fiber stress in flexure to less than one-half that in the ordinary type of bolt. It has hitherto been impossible to employ in stay-bolts any of the steels containing chromium, nickel, vanadium, etc., possessing properties especially adapted to this class of work, but these steels can readily be used in the stem of the bolt described. This stem can be flexibly secured to the end in one of the customary ways, but the flexibility of the bolt does not depend upon a flexible connection. A type

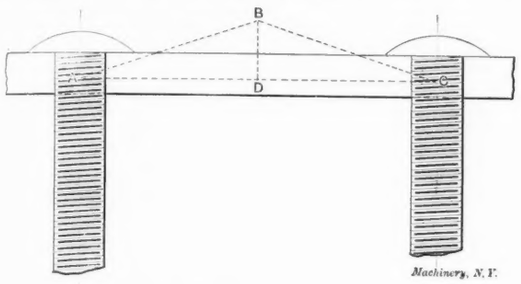

Fig. 5. Manner in which Plates Buckle with Rigid Stays

of bolt with a relatively inflexible connection, usually one in which the stem screwed into the ends with a running fit, has met with the most favorable consideration. Such a bolt is flexible as a spring is flexible, in that it can be deflected to meet the requirements of service without exceeding the elastic limit. In fact the stem may be of a number of pieces, either of plates or small rods, thus increasing its flexibility.

The actual breaking strength of the bolt sizes ordinarily employed is shown in the following statement. These bolts were recessed to the base of the thread and tested in the same form as that in which they are employed in service. For comparison, the approximate weights of the usual length of bolt are also given. These weights are for bolts over the entire length, including the squared ends for screwing the bolts into the sheets.

ACTUAL BREAKING STRENGTH OF STAY-BOLTS

Type	Nominal Diameter	Actual Breaking, Pounds	Weight, Ounces	Vibrations
Iron	1 inch	32,500	20	6,000
Iron	$\frac{7}{8}$ inch	24,500	15	5,200
Spring steel stem	1 inch ends, $\frac{7}{16}$ inch stem	32,000	10	500,000

The vibrating test was made by clamping one end of the bolt in a machine and revolving the other end through a radius of 3/32 inch, the specimen being 6 inches long from the end of the right head to the center of the rotating head. A tensional load of 4,000 pounds was also applied to the bolts. The best grades of iron bolts break on being subjected to from 5,000 to 6,000 rotations, whereas the spring steel bolts were vibrated 500,000 times without failure, and on some of them the test was continued without failure to 1,000,000 vibrations. These tests demonstrated that the bolt is not stressed beyond the elastic limit under these severe conditions, and that the probability of its failure in less severe conditions is very remote.

The extent of the expansion which can take place in the fire-box of a boiler can readily be calculated:

Distance between stay-bolts, 4 inches.

Temperature of inside sheet, 400 degrees F.

Temperature of outside sheet, 100 degrees F.

Coefficient of expansion, 0.0000066.

Then the expansion between two bolts will equal: $0.0000066 \times (400 - 100) \times 4 = 0.0079$, and each bolt will deflect 0.00395 inch. It has been shown that this amount of deflection will stress the usual type of bolt (about 6 inches long) beyond the elastic limit. In practice, however, one bolt may hold rigidly, throwing the entire deflection on the adjacent bolt, or neither bolt may deflect and the sheet will then buckle. Under this condition the neutral axis will assume the form *ABC*, Fig. 5, and the length *AB* will equal 2.00395 inches and the sheet will buckle to an extent, $BD = \sqrt{2.00395^2 - 2^2} = 0.125$ inch. It is obvious that the repetition of a force sufficient to buckle a sheet $\frac{1}{8}$ inch must ultimately lead to a crack in the furnace sheets. If, however, the bolt deflects, allowing the sheet to normally expand, the latter will be relieved of these extraneous loads.

A bolt of sufficient flexibility to deflect under the forces following expansion, and of material which will not be stressed beyond the elastic limit in resisting these forces, will greatly assist in reducing the cost of boiler maintenance by eliminating broken stay-bolts and reducing the stresses in the furnace plates. If in addition the bolt has a smaller diameter, the life of the furnace plates should be further increased, as such a bolt will interpose less obstruction to the circulation of the water in the water legs.

* * *

HORSE-POWER FORMULA FOR AUTOMOBILE ENGINES

In the August, 1907, issue of MACHINERY, engineering edition, a horse-power formula for gasoline engines, adopted by the Association of Licensed Automobile Manufacturers, was given. This formula is

$$H.P. = \frac{D^2N}{2.5},$$

where D = diameter of cylinder in inches,

N = number of cylinders.

According to a paper read by Mr. James L. Miller before the Glasgow Technical College Scientific Society, this formula gives, however, in general, an underestimate, especially for the larger sizes, and the following formula, which gives better results, is recommended:

$$H.P. = K \times D\ (D - 1) \times (R + 2) \times N.$$

In this formula

K = constant = 0.197 for commercial and touring cars and 0.33 for racing cars,

D = diameter in inches,

$R = \frac{\text{stroke in inches}}{\text{diameter in inches}}$ = ratio between stroke and bore,

N = number of cylinders.

Applying this formula to a four-cylinder engine with four inches diameter of cylinders and five inches stroke gives 31 H. P., which could be obtained from such an engine at quite moderate speeds. The Automobile Manufacturers' formula gives in this case only 25.6 H. P.

* * *

CHILLED CAST IRON LATHE TOOLS

A contributor to the *Mechanical World* mentions that he has tried chilled cast iron tools with considerable success when turning plain work. The shank of the tool was about ten inches long by two inches square, and the cutting portion was made of the ordinary round-nose shape, suitable clearance being provided, but no top rake employed. The required hardness of the tool nose was obtained by a chill-box. The molten metal which enters the chill-box is rapidly cooled, and when removed from the sand the tool nose is extremely hard. All that is necessary is to grind it, and it is ready for use. A decided feature of its characteristics is its ability to cut cast iron which has been chilled through being poured into damp molds. Tools of this kind, it is stated, have, in a number of cases, saved partly machined work from being scrapped, when the best brands of high-speed steel were unequal to machining the cast iron. Tools of this type are handy to have around for occasional jobs which show themselves unamenable to ordinary methods. The use of chilled iron tools dates back many years. Its use at Lister's Works, Darlington, England, to turn chilled iron rolls, was mentioned in Moore's Guide, a heterogeneous collection of receipts and formulas for mechanics, grocers, lawyers, doctors, etc., published a long time ago. Some chilled rolls had been made so hard that carbon steel tools could not be used. One of the workmen suggested that if the chilled iron was harder than hardened steel, it might be found that a chilled iron tool might be made to cut as it could be made as hard or harder than the roll. The suggestion was successfully followed.

A SPRING WHEEL FOR THE AUTOMOBILE

In order to avoid the trouble and expense connected with the penumatic tire, a number of wheels of different types have been constructed, all with the object in view of obtaining a resiliency equal to that of the pneumatic cushion, by

Fig. 1. The Seaton Spring Wheel for Automobiles, Trucks, etc.

the use of springs. Practically all of these spring wheels have employed radial springs, spring spokes or hub springs, and the objection has been that all of the load at a given

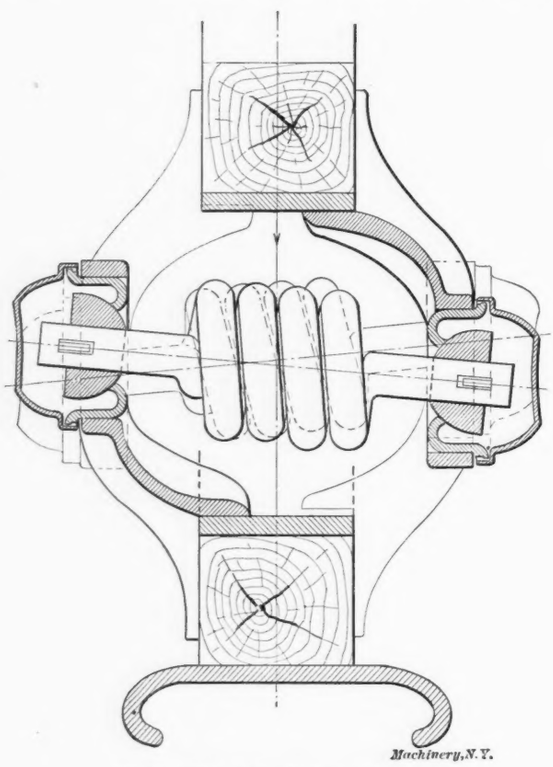

Fig. 2. Action of the Springs under Load

time is concentrated on a few of the springs. With the springs arranged radially, there is also a tendency for the wheel to "dish," because of the lack of rigidity against lateral shocks. The American Spring Wheel Co. of Cleveland, Ohio, has placed upon the market a wheel which is both novel and ingenious in its construction, and one which, judging from its design, and the results of the tests, is applicable not only to pleasure, but also to commercial vehicles.

This wheel, which is known as the Seaton spring wheel, is constructed in two parts, an inner wheel or hub, and an outer part with a solid rubber tire, which corresponds to the felloe and tire of the ordinary wheel. These two parts are connected by springs set parallel to the axis of the hub, and with their ends held in brackets which extend radially from the two main parts of the wheel. As will be seen by referring to the engraving, Fig. 1, one end of each alternate spring is connected to the bracket of the inner rim, and the other to the bracket of the outer rim. These connections, however, are not rigid, as the ends of the springs are attached to their brackets by ball-and-socket bearings. A detail of one of these springs with the bracket and bearing in section, is shown in Fig. 3. The brackets *A* are turned to fit the steel-bound

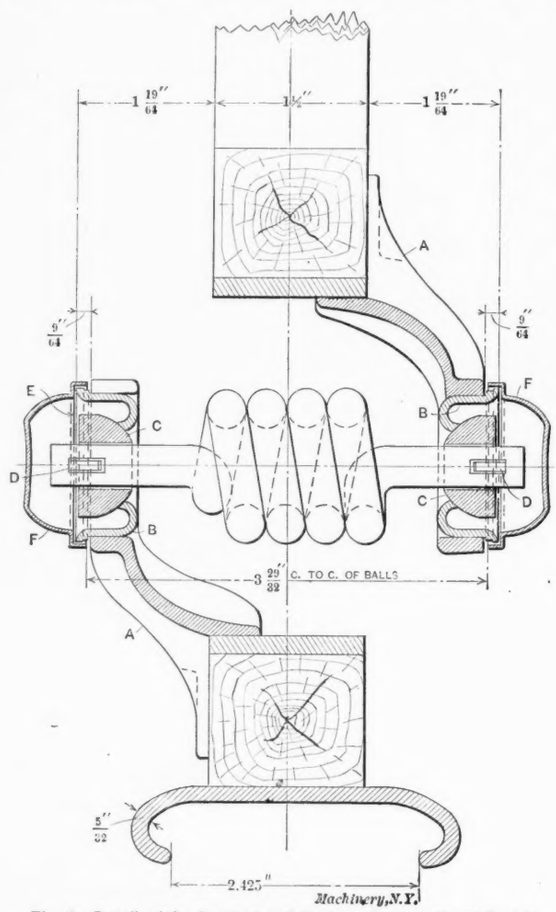

Fig. 3. Detail of the Bracket and Spring, showing the Ball and Socket Bearing

felloes to which they are bolted, and they are also bored to fit the case-hardened cups *B* which form the seats for the bearings. The hemispherical balls *C* are slotted for the cotter-pins *D*, which pass through slots in the spring at each end, thus holding it in place. There are three slots of slightly varying depths cut across the flat of each of the half balls, so that springs of different lengths may be assembled with practically the same tension. By this construction each spring is enabled to accommodate itself to varying shocks, and by reason of the movement allowed by the ball bearing it is, practically speaking, only subjected to a straight pull. The springs in the assembled wheel are under an initial tension or stretch, of about 1/16 or 3/32 of an inch, in order that each one will take its full share of the load or shock at every point of the revolution. This spring arrangement, as is evident by examining the illustrations, gives the wheel considerable lateral strength. The normal position of the springs is parallel to the axis of the wheel, but when the inner section is subjected to a load, it moves downward against the tension of each spring which is also displaced from its parallel-to-the-axis position, as indicated in Fig. 2. As this downward

movement of the inner wheel takes places, the hemispherical parts of the spring bearing roll in their seats and, consequently, the springs, as before stated, are subjected to a stress which is parallel to their axes.

The bearings are lubricated with hard grease which is placed into the cavities *E* (Fig. 3). As is well known, grease is a lasting lubricant, and it also has the advantage in this case of protecting the bearing by its gradual outward flow, from dirt and other gritty substances which might otherwise enter from the inside. The lubricant itself is kept clean by the caps *F* which are held in place by a flattened part of the rim, which engages with a collar on the bearing cups *B*.

The one feature of the construction of this wheel which is basic in principle, and indicative of careful thought, is the arrangement of the springs, and the most valuable feature of the wheel from a mechanical point of view, lies in the fact that the load is evenly distributed over all the springs. This, of course, makes the use of a comparatively light spring possible, which adds to the resiliency of the wheel. It is said that the riding qualities of the Seaton wheel compare favorably with the rigid type equipped with a pneumatic tire.

Mr. Hubert H. Ward, Mr. William E. Metzger, formerly of the Everitt-Metzger-Flanders Co., of Detroit, and others have organized the American Spring Wheel Co., to manufacture the wheel in this country, while the International Spring Wheel Co. has been incorporated to handle the foreign patents. Mr. H. L. Olmstead, formerly assistant engineer of the Brown Hoisting & Conveying Co., of Cleveland, has been made mechanical engineer for the American firm.

* * *

FORMULAS FOR STRENGTH OF FLAT CIRCULAR PLATES*†

WM. F. FISCHER‡

When a flat circular plate becomes deformed under the action of a given load *W* applied normal to its surface, as shown in Fig. 1, the upper fibers *B* of the material are subjected to compressive stresses both radially and circumferentially, while the lower fibers *C* are subjected to tensile stresses both radially and circumferentially. This is caused by the

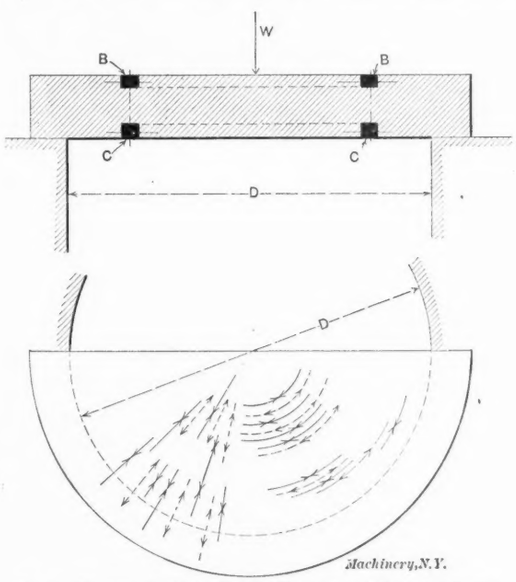

Fig. 1. Stresses in Flat Circular Plates Loaded at the Center

fact that the plate, when bending, tends to assume a spherical shape. Stresses therefore, appear in the plate in a manner as indicated in the lower view in Fig. 1. The deformation of the plate as shown in an exaggerated scale in Fig. 2, tends to decrease the length or circumference of the upper fiber *B*, while it tends to increase the length of the lower fiber *C*. In the lower view in Fig. 1, the full lines with their arrows show the direction of the radial and circumferential compression stresses in the fibers on the upper side of the plate, and the dotted lines with their arrow-heads show the tension in the fibers on the lower side of the plate.

In the accompanying Supplement, several sets of formulas for circular plates are given, selected from different authorities. The formulas are presented as given by the various writers, and then the different quantities "safe load," "unit stress," "thickness of plate," etc., as deduced from the given formulas, are shown. The tables given should be considered

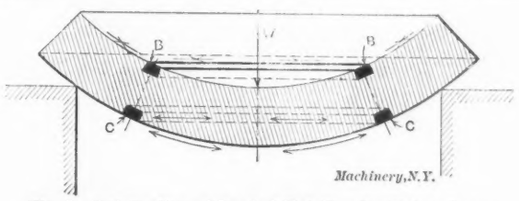

Fig. 2. Deformation of Loaded Flat Circular Plates shown in Exaggerated Scale

as a part of a complete set of tables giving formulas of flat plates, four of which were published in the Supplement to the June, 1909, issue of MACHINERY. Table V refers to rectangular plates, and Tables VI, VII and VIII to circular plates.

Exact formulas for finding the bending moments in flat circular plates and the resistance of plates to the stress created by pressures normal to their surface have not as far as the writer knows, been determined. The formulas given are founded on certain assumptions and must be considered merely as approximations. This, of course, is also indicated by the variations in the formulas given by the various writers on the subject. The formulas should be used with caution, and such formulas as give results on the safe side should be preferred. In deriving formulas of this character, all assumptions should be made so that the error is on the safe side.

* * *

ZEPPELIN'S LAST RECORD—THE DE BAUSSET VACUUM AIRSHIP

Count Zeppelin's new air-ship covered a distance of about 850 miles in 37 hours, starting from Friedrichshafen, Germany, May 30. Unfortunately the air-ship collided with a tree on the return trip from Bitterfeld. The impact smashed in the bow, but damages were repaired in a few hours and the return flight to Friedrichshafen was resumed. The success of Zeppelin's mammoth air-ship has caused some enthusiast to predict that a transatlantic trip will be made possible within a year, inasmuch as it is claimed that the possibility of such a trip is merely a question of fuel and supplies.

The success of this air-ship has also revived the De Bausset vacuum air-ship plan, which was promoted—and ridiculed—about twenty years ago. The plan of Dr. De Bausset was to build a huge steel cylinder over 700 feet long, internally stiffened so as to resist the external air pressure when the contained air was pumped out. It was the idea that a large vessel thus made of steel could be given sufficient buoyancy by pumping out the air to cause it to rise. The advantage of the plan, of course, is that there is no danger from explosion as in the case with gas. Another advantage is that the buoyancy of the balloon can be increased and decreased at will by simply pumping out the air or admitting it as the case may require. It is claimed that De Bausset had worked out his plan for a ship 744 feet long, having a diameter of 144 feet, the total displacement being about 11,000,000 cubic feet. The displaced air at sea level and at a temperature of about 65 degrees F. would weigh about 400 tons, which, of course, would be the measure of buoyancy, minus the weight of the cylinder, car, machinery, supplies, etc. It was calculated that the vacuum air-ship could be built so as to have a net lifting power of about 124 tons. The plan of interior construction by which the enormous pressure of the atmosphere could be resisted by a structure sufficiently light to answer balloon purposes has never been revealed. It is said that De Bausset had worked out the plan satisfactorily, but he never revealed it to others. The skin of the cylinder was to be made of rolled steel, ¼ inch thick. Beyond that nothing of the interior details is known, except that the air was to be exhausted by four powerful pumps, driven by electric motors, supplied by rolled batteries. C. A. McCready, of the New York Produce Exchange, is responsible for the effort to revive the project.

* With Data Sheet Supplement.
† See also MACHINERY, June, 1909: Formulas for Strength of Flat Plates.
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THICK CYLINDERS*

P. M. GALLO†

The calculation of the thickness of cylinders for a given pressure has been so much discussed, and so many formulas have been deduced, some theoretical and others empirical, that there seems to be little to add. Yet this subject is so little understood that every experienced engineer relies on his own experience, and in most cases uses no formula at all, except a kind of proportional one, that is usually all right for limited pressures and sizes of cylinders, but which conforms neither with theory nor practice; but "it does the work," as the uninitiated say. Some formulas, although published in reputable engineering hand books, are absolutely worthless. Others, again, are good for high pressures but valueless for low pressures, and *vice versa*.

The writer has had considerable experience in this line of work, having designed the complete hydraulic, steam, and pneumatic power transmission system for the largest tube and pipe mill in the world, and has, therefore, given this subject considerable thought.

Commonly Used Formulas

In low pressure work the general practice is to make the thickness of the metal = diameter × unit pressure ÷ twice the allowable working stress of the material, and add to this a variable quantity to allow for unsound castings and possible unknown stresses, or

$$t = \frac{D\,P}{2\,S} + a \qquad (1)$$

Where t = thickness in inches,
D = diameter in inches,
P = pressure in pounds per square inch,
S = allowable tensile stress in pounds per square inch,
a = variable quantity.

The quantity a varies with the size of the cylinder and the pressure, and with the conditions under which the cylinder is operated.

For high pressures Lamme's formula is usually used and gives reliable results. This formula, transformed for practical application, is:

$$t = r\left[\sqrt{\frac{S+P}{S-P}} - 1\right] \qquad (2)$$

Where t = thickness in inches,
S = allowable tensile stress in pounds per square inch,
P = working pressure in pounds per square inch,
r = internal radius.

This formula is arrived at theoretically and expresses the exact relations between the tensile stress and the working pressure of an elastic material, with the exception that it does not take the lateral contraction of the material under stress into consideration; this can be omitted for practical purposes, since the variation of the quality of the material, unsound castings, and conditions of service, more than counterbalance the gain by considering the lateral contraction.

For those that care to note the difference between Lamme's formula and the one considering lateral contraction, the latter, for cast iron and steel, using the same notation as before, is given below.

$$\text{For cast iron } t = r\left[\sqrt{\frac{4\,S+P}{4\,S-4\,P}} - 1\right] \qquad (3)$$

$$\text{For steel } t = r\left[\sqrt{\frac{3\,S+P}{3\,S-4\,P}} - 1\right] \qquad (4)$$

Whereas Lamme's formula is the same for any material, the latter formula varies with the material, since the lateral contraction varies. This contraction is about ¼ for cast iron and 1/3 for steel.

For pressures ordinarily used in hydraulic work formulas (3) and (4) give a thinner cylinder than (2); but for very high pressures, such as occur in guns and sometimes in intensifiers, formulas (3) and (4) give thicker cylinders than (2). Unless one is positive of a high-grade material and sound castings, cast iron should not be used on pressures over 2,000 pounds per square inch.

Formulas (2), (3) and (4) are deduced on the supposition that the inner laminae of a cylinder rupture first, and the moment rupture occurs, the stress on the material is increased, due to the diameter being increased by the starting rupture, and the rupture continues to the outer lamina, or, commonly speaking, the cylinder is "burst." Accordingly, the formulas give such a thickness that the pressure on the inner lamina does not exceed the allowable tensile stress, provided the assumed working pressure is not exceeded. The pressure on each succeeding lamina varies as the square of its radius. For the deduction of Lamme's formula, see Merriman's "Mechanics of Materials."

Since these formulas are deduced from the above assumptions, there must be some limited working pressure for each assumed allowable tensile stress, which, if exceeded, will produce a stress on the inner lamina exceeding this allowable tensile stress, even if the cylinder were made infinitely thick. We will now inspect Lamme's formula to find this limited working pressure. By making $P = S$, we have

$$t = r\left[\sqrt{\frac{S+S}{S-S}} - 1\right] \text{ or } t = \infty.$$

Therefore, S is, theoretically, the limit of working pressure; of course, practically it is much lower than this for economical reasons. The writer takes the thickness equal to the radius as a practical limit; if greater thickness is required a higher value for S is used, and consequently a lower factor of safety, or a better grade of material is employed.

In formula (4) make $P = \frac{3}{4}S$, then

$$t = r\left[\sqrt{\frac{3\,S+0.75\,S}{3\,S-3\,S}} - 1\right] \text{ or } t = \infty,$$

In this formula the limit of working pressure is $\frac{3}{4}S$, showing that the thickness increases much more rapidly as the pressure increases than it does in formula (2). In formula (3), again, $t = \infty$ for $P = S$.

Another formula frequently used is

$$\frac{t}{r} = \frac{P}{S}\left(1 + \frac{P}{S}\right) \qquad (5)$$

This is an empirical formula giving results agreeing very closely with those obtained by formula (2) for limited pressures; it does not give the true relation between S and P, and it is simply a modification of (1) with the quantity a replaced by the factor $\left(1 + \frac{P}{S}\right)$ which factor does not vary correctly with increased pressures and stresses. Make $P = S$ and we get

$$\frac{t}{r} = \frac{S}{S}\left(1 + \frac{S}{S}\right) = 2$$

or the thickness is equal to $2r$; even if we make $P = 2S$ we get a thickness apparently sufficient for the pressure; but to find what the actual tensile stress produced will be under such a pressure, we are compelled to resort to formula (2). The formula (5) is theoretically and practically wrong.

Conditions Governing the Thickness of Cylinders

Having investigated various formulas used for calculating the thickness of cylinders and given a fair average practice, we will now go into the conditions that govern the thickness of cylinders.

1. Two castings taken from the same cast vary widely as to chemical and physical qualities and soundness, depending on what part of the cast each is taken from, conditions of mold, etc. Castings from different casts vary still more.

2. There is a limited thickness below which casting is impossible; this varies with the kind and quality of metal and the skill of the men.

3. Castings handled by unskilled crane men receive very severe shocks and knocks, often producing stresses far in excess of the stress produced in service.

* For additional information on thick cylinders, previously published in MACHINERY, see Design of Thick Cylinders, July, 1907, engineering edition, and the articles there referred to. See also MACHINERY'S Reference Series, No. 17, Strength of Cylinders.

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4. In hydraulic systems, the cylinders are subjected to shocks, the magnitude of which depends largely on the design of the system, the service for which the cylinder is used, and the construction and method of operation of the valves.

As far as the variation of the chemical and physical properties are concerned, that is taken care of by the factor of safety. The soundness of the casting is taken care of by allowing an additional amount of metal; this varies with the kind of material, being more for cast iron than for brass, for instance. The amount to be added increases in a certain ratio as the diameter increases, and decreases in a certain ratio as the pressure increases. The increasing pressure requires more body to the metal; therefore, the casting is sounder and less metal need be added. In fact, for pressures above a certain limit this addition of metal can be omitted altogether.

The amount of the addition depends on the quality of the metal and the allowable tensile stress, and should be proportioned accordingly by the designer. With a good quality of metal, the castings can be made thinner, and yet be sound. With a higher allowable tensile stress, the castings are thinner for a given pressure than with a lower, and consequently more metal must be added to make a sound and reliable casting.

The limit of thickness below which casting is impossible varies with the quality of metal used, and should be decided by the designer's experience and judgment.

From the conditions enumerated, the writer has deduced a formula, conforming with theory and practice, which can be used for any working pressure high or low and any allowable tensile stress. For the primary thickness for the pressure, formula (2) is used. Then add two quantities, one increasing as the diameter increases, and one decreasing as the diameter increases (but not in the same ratio as the first quantity), and both decreasing as the pressure per square inch increases. Following is the formula:

$$t = r\left[\sqrt{\frac{S+P}{S-P}} - 1\right] + \frac{S-P}{S}(0.452 - 0.0061\,D) + \left(\frac{S-P}{S+P}\right)^5 0.023\,D \qquad (6)$$

The notation is the same as previously given.

Now let us inspect this formula:

Make $P = S$ and we get

$t = x + 0 + 0$,

which is theoretically correct.

Now let us make $P = 0$ and we get

$$t = 0 + (0.452 - 0.0061\,D) + 0.023\,D,$$

which is the minimum thickness. For a two-inch cylinder this would be $t = 0.4398 + 0.046 = 0.4858$ inches, and for a thirty-inch cylinder, $t = 0.269 + 0.69 = 0.959$ inch, or for a sixty-inch cylinder, $t = 0.086 + 1.38 = 1.466$ inch. These thicknesses are within the limits of possibility of casting, and the formula is, therefore, correct from a practical standpoint.

Diagram for Calculating Thick Cylinders

From the diagram, Fig. 1, the thickness of cylinders can be taken directly for any working pressure up to 5,600 pounds per square inch, and for the commonly used fiber stresses.

The line $A\,B$ is the base line on which the fiber stress curves are constructed. A 32-inch diameter cylinder was the maximum considered in plotting the curves, but the diagram can be made to read up to 40 inches diameter by extending the diagonals, reference from the fiber stress curves always being made to the base line $A\,B$. By letting the diagonals encroach on the fiber stress chart, the limit will be the full extent of the chart; the 5,600 line or the maximum diameter of cylinder would thus be 96 inches diameter. The formula is developed for a maximum diameter of cylinder of 74 inches, above which the second turn of the right-hand member becomes negative.

The location of the fiber stress curves with respect to each other is proportional to the respective fiber stress values measured along the ordinates. For if $S = 7{,}000$ pounds per square inch is required, divide a number of intervening ordinates between the 6,000 and 8,000 pound curves in half, and draw a smooth curve through the points thus located. If $S = 6{,}500$ pounds is required, the points are located one-quarter of the length of the intervening ordinates above the 6,000 pound curve. Therefore, any number of curves can be plotted with little trouble.

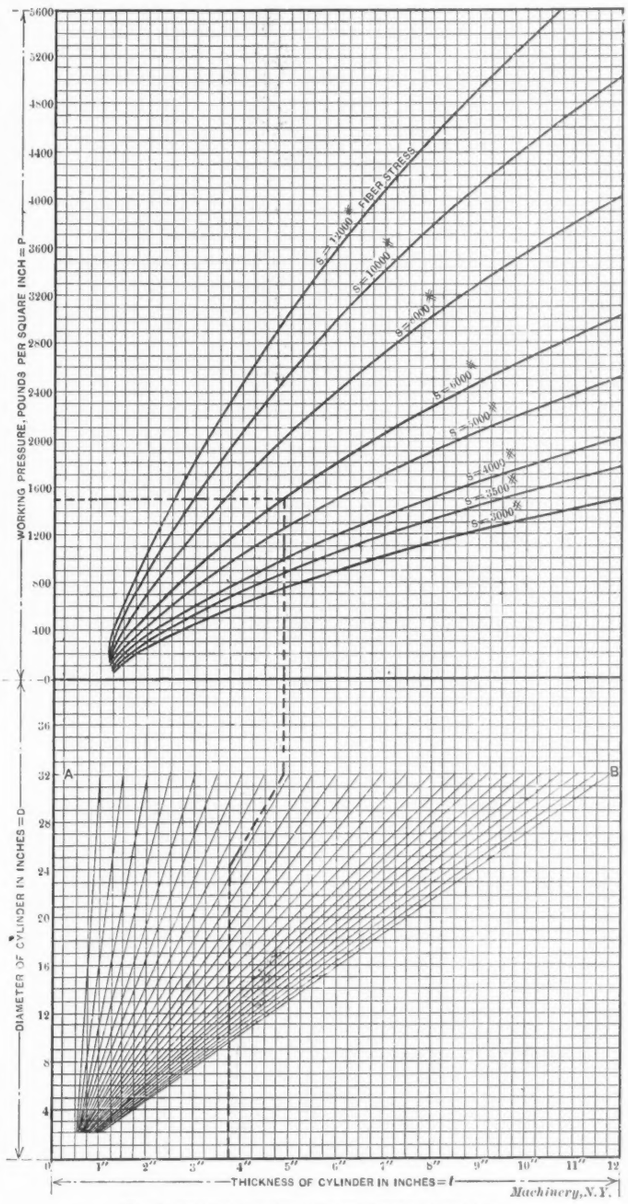

WORKING PRESSURE, POUNDS PER SQUARE INCH = P
DIAMETER OF CYLINDER IN INCHES = D
THICKNESS OF CYLINDER IN INCHES = t
S = 12000 # FIBER STRESS
S = 10000 #
S = 9000 #
S = 8000 #
S = 7000 #
S = 6000 #
S = 5000 #
S = 4000 #
A
B
Machinery, N.Y.

Fig. 1. Diagram for Calculating Thick Cylinders

Formula on which diagram is based:

$$t = r\left[\sqrt{\frac{S+P}{S-P}} - 1\right] + \frac{S-P}{S}(0.452 - 0.0061\,D) + \left(\frac{S-P}{S+P}\right)^5 0.023\,D$$

in which t = thickness of cylinder in inches,
S = allowable fiber stress in pounds per square inch,
P = working pressure in pounds per square inch,
r = internal radius of cylinder in inches,
D = internal diameter of cylinder in inches.

Example of use of diagram: Required, thickness of cylinder, $D = 24$ inches, $P = 1{,}500$ pounds, $S = 6{,}000$ pounds.

Follow horizontal line from $P = 1{,}500$ to 6,000-pound curve; then follow vertical line down to base-line AB; then diagonal line until opposite 24-inch diameter; then vertical line to bottom scale, where the thickness ($= 3\frac{3}{4}$ inches) is read off.

For intermittent stresses, such as for cylinders for steam and hydraulic work, $S = 3{,}000$ pounds for cast iron, $S = 5{,}000$ pounds for ordinary brass, and $S = 10{,}000$ pounds for steel castings is ordinarily used by the writer.

For steady or gradually applied stresses, such as pipe line fittings, cast pipes, pneumatic cylinders, etc., the stresses should be: for cast iron, $S = 3{,}500$ to 4,000 pounds, for brass, $S = 6{,}000$ to 7,000 pounds, and for steel castings, $S = 12{,}000$ pounds per square inch.

If the cylinder is turned on the outside and bored, the thickness given in the chart is too high for working pressures up to 500 pounds, and the thickness can be decreased by the following amounts with safety. Let T be the thickness required and let t be the thickness taken from the diagram, then

$$T = t - \frac{500 - P}{500}(0.31 + 0.0146\,D),$$

in which D = diameter of cylinder. It will be seen that for 500 pounds $T = t$.

For pressures of 2,000 pounds and over, cast iron should not be used, especially if subjected, additionally, to bending and tensile stresses due to external forces, as the factor of safety becomes too low, and the thickness prohibitive; even when an extra good quality of cast iron is used, such as gun iron, 2,000 pounds is about the safe limit, because it is not possible, in most cases, to determine the maximum pressure due to shocks, etc. Even if the pressure due to shocks comes within a reasonable limit, the cast iron will not last long under repeated shocks. An idea of the life of materials under repeated blows or shocks can be found in Merriman's "Mechanics of Materials."

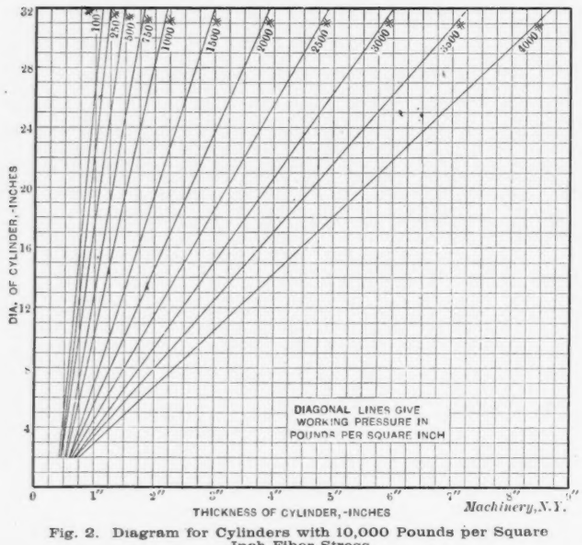

DIA. OF CYLINDER,-INCHES
THICKNESS OF CYLINDER,-INCHES
DIAGONAL LINES GIVE WORKING PRESSURE IN POUNDS PER SQUARE INCH
Machinery,N.Y.

Fig. 2. Diagram for Cylinders with 10,000 Pounds per Square Inch Fiber Stress

In low pressure cylinders, the thickness of metal is much greater than the working pressure requires, but must be such to obtain a good sound casting, and the actual pressure that could be put on such a cylinder without exceeding the allowable tensile stress of the material can be found by the following formula:

$$p = S\frac{R^2 - r^2}{R^2 + r^2} \qquad (7)$$

Where R = the outer radius, the remainder of the notation being the same as before.

To find the tensile stress that a given pressure produces, simply transpose the above formula and solve for S; thus,

$$S = p\frac{R^2 + r^2}{R^2 - r^2} \qquad (8)$$

Having now developed a practical formula for cylinders for any pressure and tensile stress, and inspected various existing formulas, there remains little more to say except that many formulas, in general, are correct for the conditions and assumptions for which they were developed; but owing to the authors of these formulas and engineering handbooks failing to state these conditions and assumptions, combined with the inability of the majority of engineers and draftsmen to apply formulas correctly, often impossible results are obtained, and the formulas are always doomed as being unreliable and incorrect. Of course, the man that uses them is never at fault. It may therefore be well to state a few points as to the application of the writer's formula.

The thickness obtained is the true thickness of the cylinder rough or finished. If the plunger works by displacement, as it generally does in hydraulic work, or with non-compressible fluids, t is the rough thickness. If the cylinder is finished, t is the finished thickness. If the cylinder is to be rebored, t must be figured for the rebored cylinder, and the amount allowed for reboring must be added on the inside, even if a steel tube is to be forced into the rebored cylinder to obtain the original diameter. If the cylinder is subjected to shocks, this must be allowed for. In hydraulic work the shocks can usually be calculated approximately; not necessarily what the effect of the shocks actually will be, but the maximum effect under working conditions. In well designed piping systems the effect of shocks in a high pressure system is, contrary to general opinions, less than in a low pressure system for the same work.

Calculate the thickness for the static pressure, and investigate this thickness for tensile stress produced by the possible maximum shock under working conditions; if the stress comes within reasonable limits the cylinder is satisfactory. For cast iron the maximum tensile stress due to shock should not exceed 4,000 pounds when often repeated, or 4,500 pounds when rarely repeated. For brass 6,000 to 7,000 pounds, and for steel, 15,000 to 17,000 pounds are average values.

In case of hydraulic test pumps, especially as used for testing pipes, where the pipe is first filled with low pressure water before the test pressure is applied, no matter how suddenly the pressure is applied, the stress in the material cannot rise above that due to double the working pressure, since the water is not in motion, or inappreciably so. But in cylinders operating plungers, a maximum stress many times greater than the initial static pressure may result owing to the inertia of the moving water suddenly brought to rest. If the cylinder also acts as a support, the thickness need not be increased, even if the compressive stress is nearly equal to the allowable tensile stress, a case found in hydraulic accumulators, where the plunger remains stationary, and the cylinder carries the balancing weight and resists internal bursting pressure at the same time. Yet, mathematically, the square root of the sum of the squares of the compressive stress and the tensile stress due to the weight and working pressure should not exceed the allowable tensile stress of the material. If the cylinder supports a weight producing a tensile stress, additional metal must be provided to resist this stress, exclusive of that which resists internal bursting pressures. This additional metal may be in the form of ribs, provided the thickness of the ribs is equal to the thickness of the cylinder, so as to prevent stresses due to unequal cooling or contraction. If the cylinder is subjected to bending, an additional amount of metal must be provided, the moment of inertia of which, about an axis through the center of the cylinder, is sufficient to resist the bending stress.

In addition to the diagram, Fig. 1, a diagram for 10,000 pounds fiber stress only is given in Fig. 2, showing the plotting of the curves and how the thickness increases with the working pressure. It also shows plainly that the formula (6) deduced is a straight line equation, and gives the reader a better idea of the ratio of increase in thickness than the general diagram, Fig. 1.

The writer has applied formula (6) for nearly all conditions of service, and also compared numerous values computed therefrom with the thickness employed under similar conditions by reputable manufacturers, and found, in general, a very close agreement and in many cases an exact agreement. This certainly seems to prove the reliability of this formula.

* * *

According to the *Sheffield Daily Independent*, over $1,500,000 of foreign capital has been invested in Great Britain as a result of the new Patents Act. English workman are, for the most part, employed in these new industries, but some of the foreign manufacturers have brought over foremen from their own plants, and in some cases, English mechanics have been taken abroad to be initiated in the methods of manufacture of the foreign patented articles, which are now to be manufactured in Great Britain. Up to the present time, nine patents have been revoked by the Comptroller-General.

THE MANUFACTURE OF CRANK-SHAFTS

A great deal has been published from time to time in MACHINERY and other mechanical journals describing odd jobs of crank-shaft turning and devices especially rigged up for this work, but little has been said regarding the important operations on crank-shafts which precede the turning of the pins and journals, and practically nothing has been published giving a complete description of the methods followed in plants where crank-shafts are made on a manufacturing basis. For this reason the following article describing in detail the methods used by the A. P. Witteman Co., of 112-116 North Broad St., Philadelphia, Pa., manufacturer of high-grade crank-shafts, has been prepared in order to give a general idea of the methods followed in the manufacture of crank-shafts.

The reason why the making of crank-shafts has become an important item as a specialized manufacture during the last decade is explained by the great demand created by the growth of the automobile and motor boat industries. Many manufacturers of engines for automobiles and motor boats have found it advantageous to buy the crank-shafts for their machines completely finished from firms making a specialty of this line. In order to meet the growing demand, the present shop of the A. P. Witteman Co. at Thurlow, Chester, Pa., about 15 miles south of Philadelphia, was built and equipped in 1907, and the demand for the company's product appears already to make a new addition necessary, inasmuch as the machining department of the shop is now running day and night, employing two shifts of men, the total number employed being about sixty.

When deciding upon the manufacture on a commercial basis of any article sold in a competitive market, there are two methods to follow; one is to decide upon the use of the cheapest methods of production and enter into competition on the basis of low price; another is to disregard the question of cheapness of production, if cheapness is not consistent with the obtaining of the best results in the final product, and to use only those methods which are most certain to insure a uniform and reliable product, irrespective of cost, thus entering the field of competition on the basis of quality. When deciding to manufacture crank-shafts for the trade, the A. P. Witteman Co. chose to follow the latter course, because it was evident that the demand of the market was for a high-grade crank-shaft which could be made light in weight and yet be capable of standing high stresses. Another deciding factor of commercial importance was that while the competition would be keen in the low-priced, cheaply made crank-shafts, the competition in a high quality product would be far less formidable, as the tendency of modern manufacture, unfortunately, is to sacrifice quality for cheapness of production. That the Witteman Company adopted the right course when deciding upon quality rather than low price is evidenced by the success the company has met with. Reference will be made in the following to various methods which will indicate the tendency outlined above of looking to quality first, irrespective of the fact that cheaper methods can be used to obtain what on the surface would appear to be the same results; and in this connection it is safe to say that in many other lines of manufacture, makers would find competition less keen if they devoted more time to the quality of their product rather than to reducing the price of production.

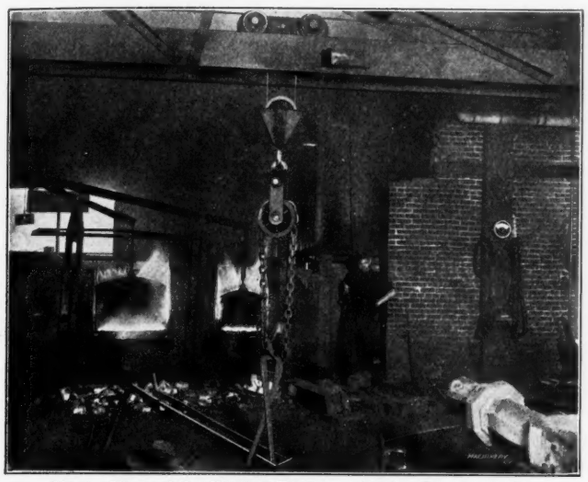


Fig. 1. View of the Heating Furnace, showing Pyrometer for gaging Heat, to the Right

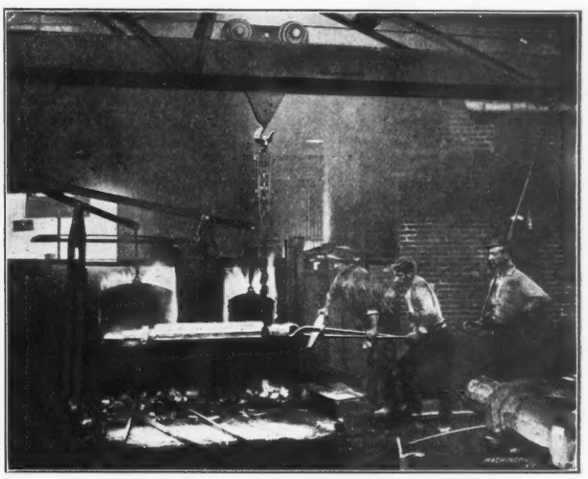


Fig. 2 A Six-throw Nickel Steel Crank-shaft Forging, ready for the Annealing Pit

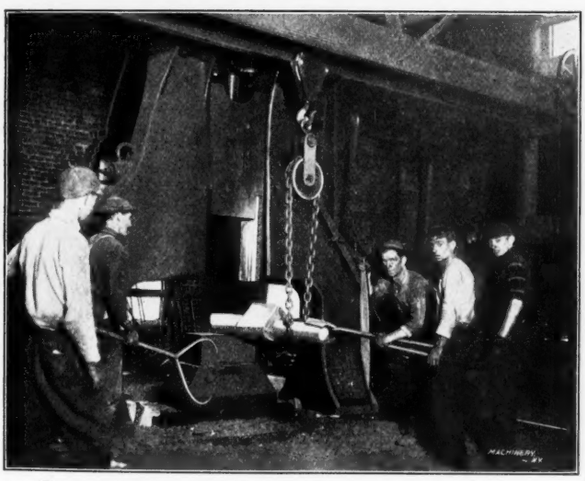


Fig. 3. A Large Crank-shaft Forging under the Steam Hammer

Fig. 4. A Collection of Huge Tongs, Fullers and Breaking-down Tools

Material Used for Crank-shafts

For high-grade crank-shafts, alloy steels are used almost exclusively, vanadium, chrome-nickel and nickel steel being the three classes of steel used by the Witteman Co. For crank-shafts subjected to less severe stresses, a good quality of open-hearth steel is also used.

The vanadium steel used, after having been subjected to proper heat treatment as explained in detail in the following, will have a minimum tensile strength of 150,000 pounds per

square inch and an elastic limit of 127,000 pounds. This is the highest grade steel that can be used for crank-shafts and is also the most expensive, its price being about fifty per cent more than that of regular 3½ per cent nickel steel.

The chrome-nickel steel used has a minimum tensile strength of 140,000 pounds per square inch and an elastic limit of 110,000 pounds. These figures, of course, refer to the steel after having been subjected to the required heat treatment. The nickel-steel used contains 3½ per cent nickel, and has tensile strength of from 110,000 to 120,000 pounds per square inch, and an elastic limit of 80,000 pounds. While the nickel steel does not possess as high a tensile strength or elastic limit as the vanadium and chrome-nickel steels, it is preferable in cases where extreme strength is

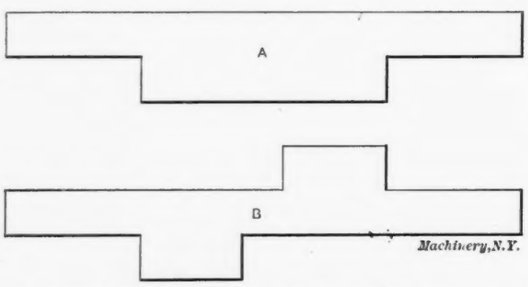


Fig. 5. Comparison of Two Methods of Forging a Two-throw Crank-shaft

not the most important object, partly because it is cheaper, partly because it is easier to obtain nickel steel of uniform quality, and partly because it is not a material requiring such expensive heat treatment as the other alloy steels. Vanadium and chrome-nickel steel require the utmost care in the heat treatment and while being worked in the forge shop, if satisfactory results are to be obtained. With proper facilities, however, and when thorough care is being used, vanadium and chrome-nickel steels make a superior product possible, although of course, the price is necessarily considerably higher.

The ordinary open-hearth steel which has proved itself best suited for crank-shafts contains from 0.35 to 0.40 per cent

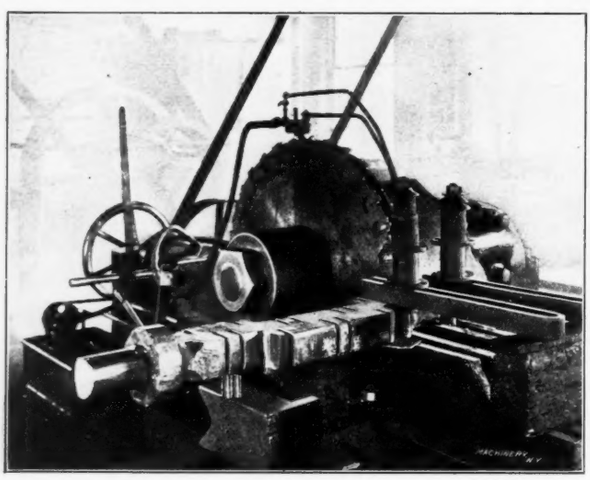


Fig. 6. Sawing out the Blocks between the Webs of the Crank-shafts

carbon, and possesses a tensile strength of from 80,000 to 90,000 pounds per square inch, and an elastic limit of from 40,000 to 45,000 pounds.

Forging Crank-shafts

All crank-shafts are forged from square billets the size of which vary from 4 to 14 inches square, according to the size of the crank-shafts to be made. While it is cheaper to make the crank-shafts from billets which have approximately the same thickness as the thickness of the webs of the crank-shaft, and a width determined by the throw of the finished crank, because of the saving in the expense of forging, it being merely necessary to draw out the ends for the journals, no reduction in the thickness of the billets being required, this method is not conducive to obtaining the best results. When a square billet is used, all parts receive approximately the same amount of hammering, and a solid forging free from flaws and with increased ability to resist stresses is obtained. Practically twice the amount of work in the forging, however, is required when following this method, because the work must go twice under the steam hammer, once for reducing the billet to the proper thickness, and a second time for drawing out the ends of the journals and forging the projections for the cranks.

The billets are heated in a furnace, a front view of which is shown in Fig. 1. The material is put into the furnace in the evening and left to soak over night, the heat being kept constant by means of a pyrometer attached to the furnace and shown to the right in the illustration. All alloy steels are heated to a temperature of 1,800 degrees F. It is very important that the steel be worked at this heat, as, if not hot enough, it is liable to crack; and if over-heated, chrome-nickel steel, in particular, crumbles under the hammer. The furnace is fired with soft coal, and a return arrangement for the combustion gases is provided, by means of which the gases are carried back into the furnace after having once passed over the grate, thus insuring perfect combustion, with the result that practically all of the heat of the gases is extracted before they pass up through the chimney. When working open-hearth steel it is not as necessary as in the case of alloy steels to keep the furnace at one constant tem-

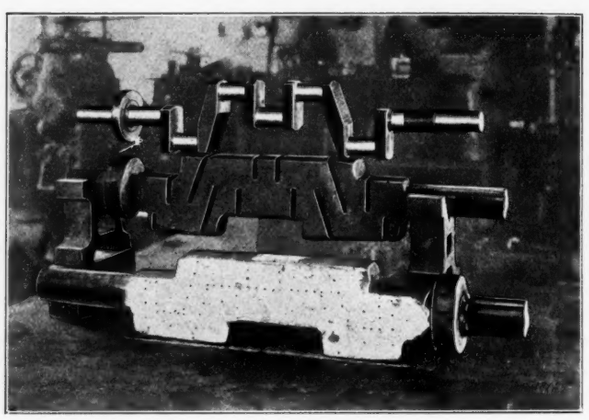


Fig. 7. Inclined Web Crank-shaft at Different Stages of Completion

perature. The heat used for open-hearth steel can vary from 2,200 to 2,500 degrees F. without impairing the quality of the finished product.

When the square billets have been heated over night in the furnace, they are worked down under the steam hammer during the next day to the proper thickness, the reduction in thickness being about fifty per cent. After having been hammered down, the billet is again placed in the furnace so as to regain the proper temperature for working, and is then taken out and blocked out under the steam hammer to the proper shape and size for the crank-shaft. When blocked out under the steam hammer, two or three men handle the forging by large tongs supported by chains, while another man operates the hammer and still another handles the fullers and other tools required for blocking out the forging. In Fig. 2 is shown a crank-shaft forging ready for the final heat treatment, and in Fig. 3, a large forging under the steam hammer, the size of which is just to be calipered. This illustration shows plainly the method used for supporting the work, and the means for turning it on the anvil.

One of the greatest expenses for the equipment of the forge shop is met with in providing the great variety of tongs, fullers and breaking down tools required. A respectable looking collection of tongs and other tools, rather larger than those which the ordinary blacksmith is used to handling, is shown in Fig. 4. Crank-shafts have been forged, the finished weight of which has been 5,800 pounds, and the shop is equipped to take care of all work up to three tons. The crane equipment and the steam hammer, however, are of a size permitting work up to five tons to be handled, if necessary.

The capacity of the 4,000-pound steam hammer used is four tons of open-hearth steel per day, or two tons of alloy steel. The reason why the production per day of alloy steel crank-

shafts is so much less, is the greater care that must be exercised when working this steel, and consequently the work must be carried on at a slower rate.

No crank-shafts are drop forged in this shop, because a drop forged crank-shaft is not as reliable as one forged in the manner outlined above.

Another method employed which differs from the commonly accepted practice, is the manner in which all two- and four-throw crank-shafts are made. Instead of forging them as

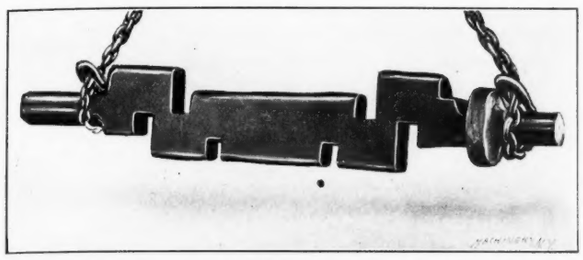


Fig. 8. Six-throw Chrome-nickel Crank-shaft, Sawed, Drilled and Blocked out, ready for Rough Turning previous to Twisting

shown at *A* in Fig. 5, blocking them out and then twisting them on the journal bearing between the cranks, the forging is made as shown at *B*, in which case each crank can be blocked out directly from the forging, thereby avoiding any twisting after the forging has been once completed. Crank-shafts made in this manner are stronger, more reliable, and more certain not to contain any fractures in the metal, but they are more difficult to make. Six-throw cranks, of course, must be twisted, but by laying out the projections for the cranks on both sides of the forging the same as in the case of two- and four-throw cranks, it is possible to avoid twisting any crank more than to an angle of 60 degrees. In this way the material is displaced comparatively little as compared with the displacement when the crank is twisted through an angle of 180 degrees.

Heat Treatment after Forging

When the forging operation is completed, nickel steel, then at a temperature of about 1,400 degrees F., goes direct from the steam hammer to the annealing pit, where it is covered with lime and permitted to remain for about twenty-four hours. This relieves the strains that would be set up by unequal cooling.

Chrome-nickel steel, after having been worked to shape at the hammer, and reduced to a temperature of about 1,500 degrees F., is immersed in cotton-seed oil, where it is permitted to cool thoroughly. It is then put back into the furnace, which is now kept at a temperature of 1,200 degrees F. for twenty minutes. This process draws the temper. The forging is then taken out of the furnace and packed in lime, in which it remains for twenty-four hours, the same as nickel steel.

Vanadium steel is quenched in oil immediately after coming from the steam hammer at a temperature of about 1,500 de-

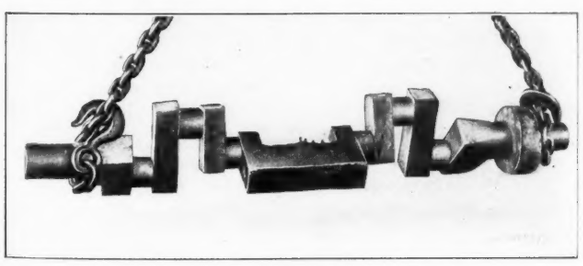


Fig. 9. Crank-shaft in Fig. 8 after having been Rough-turned on the Journals and Twisted

grees F. The temper is then drawn at a temperature of 1,000 degrees F. in the furnace for about five minutes, and the forging is then permitted to cool in the open air.

Machining Operations

The forgings are now ready for the machining operations. As the alloy steels are very difficult to machine, a low cutting speed is necessary, and it has been found that No. 5 Burgess high-speed steel works best for cutting this class of steel, when heat treated as previously described. The same steel is also used for the inserted blades in the saws used for cutting out the blocks for giving a rough form to the cranks.

When entering the machine shop, the forgings first pass to the laying out table, where they are properly laid out and marked for the blocking out of the various cranks. They then pass to the saw where cuts are taken as shown in Fig. 6. The saw is double, so that both of the cuts required for each crank are made simultaneously, the distance between the saws, of course, being easily adjustable. For crank-shafts which have inclined webs, the saw-cuts are also made inclined to the same angle as the web, so that no subsequent heating and bending of the webs will be required. No additional strains are thus set up in the web, and the material in the

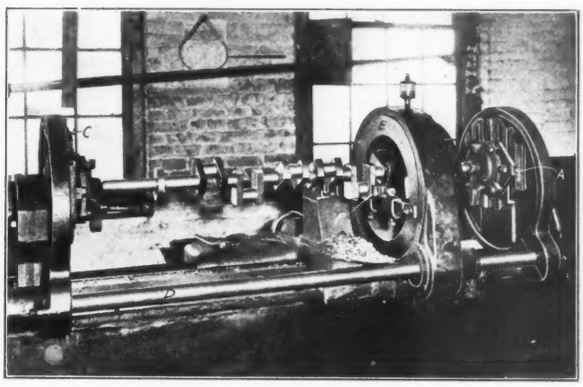


Fig. 10. Crank-pin Turning Machine

forging is not disturbed, which insures a more uniform and more reliable crank-shaft. A crank-shaft of this type is shown in Fig. 7, where the bottom view shows the forging as it comes from the forge shop, and after having been laid out and marked on its front surface. The middle view shows the same crank-shaft after the saw cuts have been made, but before the blocks between the saw cuts have been removed, while the crank-shaft on the top has been completely blocked out and rough turned on its pins and journals. This view shows in a general way the method for transforming the heavy rough forging into a slender crank-shaft.

When the saw cuts have been made, the crank-shafts pass to the drill press where one or more holes, according to the

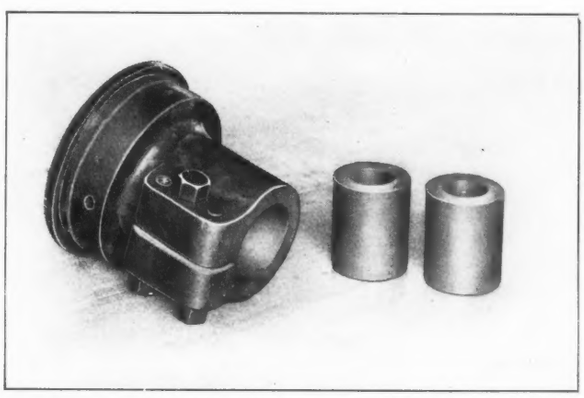


Fig. 11. Holder and Bushings for Finish Turning Crank-pins

size of the crank-shaft and the width between the webs, are drilled between the saw cuts made for each crank. Only a very thin rib of material is left between the drilled holes and the saw cuts, so that the part between the webs of the crank can easily be knocked out by a hammer or sledge. It has been found that flat twisted drills are far superior for this work to the ordinary twist drill; in fact, the ordinary high-speed twist drills would not stand up for the severe duty required of them when cutting alloy steels. When drilling vanadium or chrome-nickel steel, cotton-seed oil is used for lubricant, but for drilling nickel or open-hearth steel, as well as for the sawing operation, nothing but ordinary cutting compound is employed. In Fig. 8 a six-throw crank-shaft, sawed, drilled and blocked out between the webs, is shown.

When the cranks have been blocked out, all two- and four-throw cranks, which, as previously explained, are not twisted, go to the journal turning machines where the journals are rough-turned to about ⅛ inch over standard size. Such cranks as must be twisted also go to the journal turning machines, where the journal pins between the cranks are rough turned to about ½ inch over size, after which the crank-shafts go back into the forge shop where they are heated and twisted to the required angles. When twisting, it is very important that the heat for alloy steels be as nearly 1,800 degrees F. as possible, as a lower heat will cause cracking, and a higher heat makes the material crumble under the tools. The twisting of the crank-shafts requires special skill on the part of the operators, as the pin in which the twisting must be done is often very short, which makes the operation a difficult one. In Fig. 9 is shown the same six-throw crank-shaft as is shown in Fig. 8, after the journals have been rough-turned and the crank-pins twisted to their respective angles. The short length of the journal pin between two adjacent cranks should be noted.

When returning to the machine shop, the crank-shafts pass again to the journal turning machines where the journals are rough-turned to ⅛ inch over size, the same as for the crank-

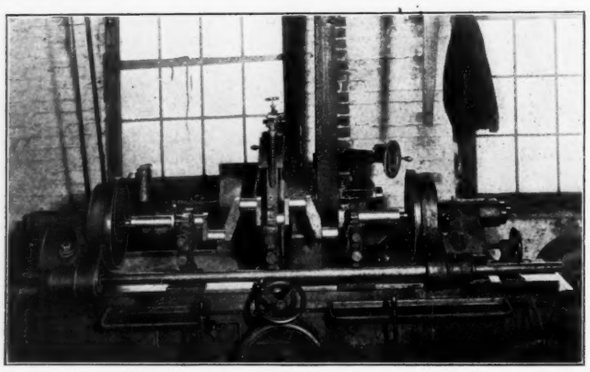


Fig. 12. Grinding the Crank-shaft Journals

shafts which are not twisted. These journal turning machines are ordinary lathes, the shafts being held on centers. They then pass to the crank-pin turning machines, one of which is shown in Fig. 10, where the pins are rough-turned to ⅛ inch over size. These machines deserve some additional explanation. The machine consists principally of a head-stock and tail-stock, on the spindles of which are mounted face-plates at *B* and *C*, and a driving head *E*. The face-plates are driven by spur gearing from a shaft *D* in the back of the machine, as shown in the engraving. From this shaft is also driven the driving head *E*, which is provided with clamping arrangements for holding and driving the crank-shafts by gripping the web, as shown at *F*. The object of this is to have the drive placed as near as possible to the crank-pin being turned, so as to avoid the twisting strains incidental to driving the crank-shaft from a point not in the immediate vicinity of the pin.

The face-plates are fitted with ways and slides, the latter having centers on which the crank-shaft is held. The slides are adjustable, and at *A* graduations are provided so that the slides can be set at the required position for turning cranks of different throws; the machine has a capacity of turning crank-shafts up to 6 inches throw. When the pins are finish-turned the centers are removed together with the bracket in which they are mounted, and instead a bushing holder as shown in Fig. 11 is mounted on the face of the slide. Various sizes of bushings can be clamped in this holder, two of which are shown to the right in the illustration. The ends of the crank-shafts revolve in these bushings, thereby insuring that the crank-pins and journals will come in a fixed relation to each other, something that would not be possible to obtain if the crank-shaft was supported on centers when the pins were finish-turned.

When the crank-pins have been rough-turned, the surplus length of the forging which is from 2 to 3 inches longer than the finished crank-shaft, is cut off and the ends again centered. The journals are then turned on the ends for the bushings in Fig. 11, already mentioned, and the crank-pins are then finish-turned while the crank-shaft is held in these bushings. One-thirty-second inch on the diameter is allowed on the pins for grinding. The webs are finished in the same operation as the pins, in the crank-pin turning lathes. Afterwards the journals are finish-turned to 0.008 inch over the finished size. The crank-shafts are now ready for grinding.

A regular Landis grinder is employed with the regular crank-pin grinding attachment, and the pins and journals are ground to size, the limit of accuracy of all ordinary work being within 0.0005 inch over or below the standard size. The webs are then finished in a shaper and during this operation the crank-shaft rests on its pins and journals, thus insuring absolute balance and preventing more material being removed from one side than from the other. While milling the sides of the webs is by far quicker and cheaper, it is much more difficult to obtain uniform results in this manner. It has been concluded that to insure absolute truth, the shaper is preferable for this class of work.

The crank-shafts are now finished except in cases where they are required to be hollow, in order to make them lighter. In such cases holes are either drilled in the drill press or bored in the lathe through the crank-pins and shaft. Hollow shafts of this description are largely used for high-speed automobile and motor boat engines.

The careful development of the definite methods employed for the heat treatment and the general procedure of the work through the forge and machine shop is due to Mr. Henry P. Arnhold, superintendent of the shop. Mr. Arnhold was for six years with the Tindel-Morris Co. before he engaged with the A. P. Witteman Co., and at the former place he developed some original methods and machines for the manufacture of crank-shafts. E. O.

* * *

In the Bureau of Standards, Washington, D. C., are doubtless the most sensitive balances in existence. They are used only for comparison and are kept, as far as possible, in a room maintained at a constant temperature and free from all outside disturbing influences. The Bureau of Standards is located several miles from the center of Washington in a region comparatively removed from manufacturing industries and railroads. The scales or balances are enclosed in hermetically sealed cases and the weights are manipulated from outside by means of levers which are so ingeniously constructed that the weights may be transferred to the scale pans and then reversed so as to check results. So sensitive are these balances that it is necessary for the operator to stand some distance away, as the heat of his body will affect the balance and cause it to vary, particularly if he stands at one side so that one weight is affected by the heat more than the other. A curious action has been discovered in the manipulation of these delicate balances, which is that a minute quantity of air penetrates the pores of the balance weights, even though gold plated as is common practice. The inflow and outflow of this minute quantity of air at various seasons of the year is said to affect the specific gravity of the weights, and to be detectable by the balance. On account of the variation produced by even such small factors, it is strongly advised by the Bureau that all weights be made in one piece and not with a screwed handle as is a not uncommon practice. The screwed handle weight has a small cavity at the bottom of the hole into which the handle is screwed, and in this cavity and the interstices of the threads is imprisoned a small amount of air. The effect of this imprisoned air is said to be very disturbing to accurate work. The screwed handle also affords opportunity for fraudulent practice, and for this reason also is discouraged.

* * *

Statistics published in the *Archiv für Eisenbahnwesen* give the total mileage of the railways in the world as follows: Europe, 199,385 miles; Asia, 56,294 miles; Africa, 18,519 miles; North America, 268,058 miles; South America, 34,911 miles; Australasia 17,700 miles. Since 1897 the world's railway mileage has increased 140,000 miles or 23.5 per cent. The total amount of capital invested in railways approximates $49,000,000,000. This corresponds to an investment of $31.50 per each inhabitant of the earth.

MACHINE SHOP PRACTICE*

SHRINKING AND FORCING FITS

When heat is applied to a piece of metal, as is commonly known, a certain amount of expansion takes place which increases as the temperature is increased, and also varies somewhat with different kinds of metal, copper and brass expanding more for a given increase in temperature than iron and steel. When any part which has been expanded by the application of heat is cooled, it contracts and resumes its original size. This expansive property of metals has been taken advantage of by mechanics in assembling various machine details. A crank-pin, or other part, which is held in position by being tightly fitted into a hole, is first turned a few thousandths of an inch larger than the hole; the diameter of the latter

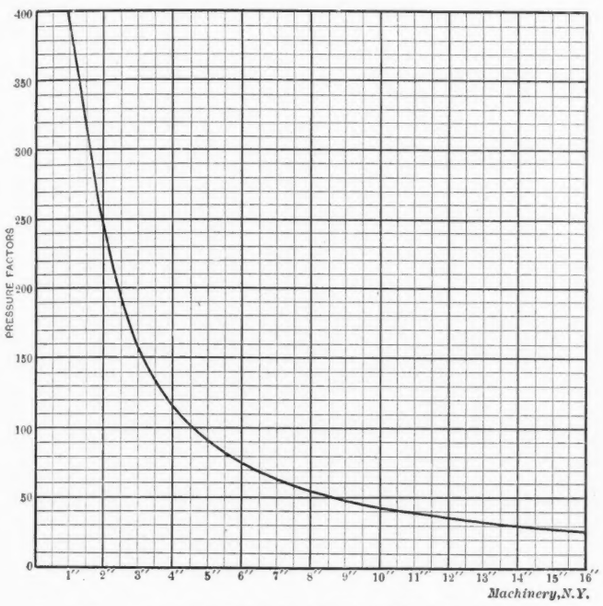


Fig. 1. Pressure Factor Curve used in determining the Allowance for Forcing Fits when a Certain Tonnage is required

is then increased by heating it, and after the pin is inserted the heated part is cooled, causing it to grip the pin with tremendous pressure. This is what is known as a shrink fit.

A force fit is the term used when a pin, axle or other part, which is somewhat larger than the hole into which it is to be inserted, is pressed into place by a hydraulic press, or other means. The crank-pins and axles for locomotive driving wheels are usually inserted in this way, while the tires are always shrunk on their wheel centers. These tires are first bored a trifle smaller than the diameter of the wheel center, and then heated sufficiently to allow them to pass over the latter. Cooling water is then applied, which causes the tires to contract and grip the wheel center tightly. When old tires are to be replaced by new ones they are, of course, easily removed by again heating them. The shrinkage allowances for tires adopted by the American Railway Master Mechanics' Association are as follows:

Center diameter, inches. . 38, 44, 50, 56, 62, 66.
Allowance, inches ..... 0.040, 0.047, 0.053, 0.060, 0.066, 0.070.

Whether parts are assembled by being pressed into place or by the shrinking method, depends somewhat upon circumstances. To press a tire, for example, over a wheel center, would be rather an awkward and difficult job, owing to its size and shape. On the other hand, a pin is easily forced into place with a hydraulic press, but if such a tool were not available, the hole could be heated and expanded sufficiently to permit the insertion of the pin by sledging, or even by hand. The hydraulic press is more economical for most work, and in addition there is an advantage in its use in that the exact pressure or tonnage required to force the part in is indicated by a gage, while there is more or less uncertainty connected with a shrink fit. If the allowance when turning a pin for a shrink fit were too great, the part into which the pin was fitted might be broken when it was cooled owing to the excessive pressure; whereas by the use of a press this danger is largely eliminated, as the approximate pressure required is known and the gage indicates just what the pressure is. Tests have demonstrated, however, that a shrink fit is superior to a force or press fit, as the assembled parts are held more securely. Let us assume that holes of the same diameter are bored in the centers of two cast iron disks of the same size, and that two pins are turned to exactly the same diameter, and a given number of thousandths of an inch larger than the holes. Now, if one of these pins is pressed into place, and the other is assembled by shrinking, the difference in the pressures required to start the pins out will be considerable, the pin which was shrunk in requiring much more pressure than the pin which was pressed into place. The force required to start these same pins by twisting or turning them in their holes would also be much greater for the shrink fit; therefore, when assembling such work as a large built-up crankshaft, or other parts which will be subjected to severe torsional stresses, it is preferable to shrink the parts together, as described in the Shop Operation Sheet accompanying this number.

TABLE OF ALLOWANCES IN THOUSANDTHS OF AN INCH FOR FORCING AND SHRINKING FITS

Shrinking Fits				Forcing Fits				
					Allowance			Allowance
Diameter	Allowance	Diameter	Allowance	Diameter	Minimum	Maximum	Diameter	Minimum	Maximum
2	0.0026	10	0.0112	2	0.003	0.005	10	0.010	0.013
3	0.0036	11	0.0122	3	0.005	0.006	11	0.011	0.013
4	0.0048	12	0.0134	4	0.006	0.008	12	0.011	0.014
5	0.0058	13	0.0144	5	0.007	0.009	13	0.012	0.014
6	0.0070	14	0.0156	6	0.008	0.010	14	0.012	0.016
7	0.0080	15	0.0166	7	0.009	0.010	15	0.014	0.016
8	0.0090	16	0.0176	8	0.009	0.011	16	0.014	0.017
9	0.0100	..	.....	9	0.010	0.011	..	... .	.....

The accompanying table gives the allowances for both forcing and shrinking fits in thousandths of an inch. After investigating considerable data collected in various shops it has been found that these allowances for different diameters represent a fair average value as taken from common practice. In some railroad shops, however, the allowances are greater than here given, while in other branches of manufacturing they are less.

The ultimate tonnage, or the pressure finally required to force a pin or other part into place, depends not only upon the allowance for the fit, but also upon the length of the bore or the area of the surface of the fit. For example, if a pressure of 20 tons is required to force a pin halfway into a crank disk, approximately 40 tons will be the ultimate pressure; therefore if a certain tonnage is required, the proper allowance may be determined by the formula

$$A = \frac{2P}{a\,(PF)}$$

Where A = the allowance in thousandths of an inch,
P = the ultimate pressure in tons,
a = the area of the fitting,
PF = a factor which may be found by the use of curve, Fig. 1, which is reproduced from one of MACHINERY'S Data Sheets.

Let us assume that we are to fit a crank pin into the disk shown in Fig. 2, and that neither the allowance nor pressure are given on the drawing. The average ultimate pressure in tons, commonly used, ranges from 7 to 10 times the diameter in inches. Taking 8 as a factor we would then have $8 \times 4 = 32$ tons. The area of the fitting equals $4 \times 3.1416 \times 5\frac{1}{2} = 69$ square inches; and the pressure factor for a diameter of 4 inches is 115, as will be seen by referring to the curve in Fig. 1. Substituting these values in the formula we have:

$$A = \frac{2 \times 32}{69 \times 115} = .008 \text{ inch}$$

* With Shop Operation Sheet Supplement.

This formula is intended for steel plugs pressed into cast iron hubs; but it should be remembered that a formula for forcing fits can, at best, only give figures which are approximate, because there are a number of factors which enter into the problem that cannot be taken into consideration. The kind and quality of the material into which a part is pressed, the smoothness of the pin and bore, as well as the taper and rotundity of either part, and the mass of metal surrounding the hole, all affect the pressure required in assembling. When a pin or other part is pressed into a hole a second time, the allowance for a given tonnage should be somewhat diminished, because the surface of the bore is more smooth and the metal more compact. Then there is the personal factor which is much in evidence in work of this kind. As machinists do not have the same sense of touch, and as some are more careful when taking measurements than others, the

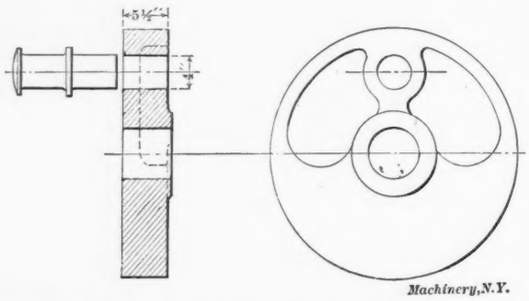


Fig. 2. An Example of the Work assembled by a Forcing Fit

results in the way of tonnage for parts which are supposed to be duplicates, often vary considerably when the work is done by different men.

By examining the formula given in the foregoing, it will be seen that the allowance for a given diameter and pressure will be greater as the area of the fitting is diminished, and *vice versa*. When parts are ready to be assembled, variations in the ultimate tonnage required can only be obtained by varying the allowance. The area of the fitting should, however, be great enough so that the allowance will not be excessive. If an effort is made to secure an ultimate pressure of say 8 or 9 tons per inch of diameter, by increasing the allowance to compensate for a small area, the resulting tensile stress upon the hub when the part is pressed into place, may be great enough to strain the material beyond its elastic limit. It is better, therefore, to secure the required ultimate pressure by changing the area of the fitting rather than the allowance, which should remain practically constant for a given diameter; of course, the length of the fitting as well its diameter are usually determined by the designer.

* * *

INVOLUTE GEARS, STANDARD

In a letter by Mr. P. V. Vernon, engineer of Alfred Herbert, Ltd., Coventry, England, published in the May 28, 1909, number of *Engineering*, he heartily advocates the cooperation of the committees appointed by the Institution of Mechanical Engineers and the American Society of Mechanical Engineers to formulate a standard of involute gears. As the matter now stands these committees will proceed independently, whereas in the opinion of Mr. Vernon they should take joint action. A great deal of experimenting is now going on in Great Britain in gear tooth forms, but as the experiments are not made under any central authority, it is doubtful that they will result in a standard that is likely to be universally adopted. The suggestion of cooperation on the part of the two committees is one worthy of serious attention. The subject is of great importance and it would be a pity to have two distinct standards adopted if it is possible to agree on a common standard.

* * *

A correspondent to the *Engineering* (London) calls attention to the fact that there is still in use, near Fairbottom, England, a Boulton and Watt engine working at three pounds pressure. The requirements of "modern industrial conditions" evidently have not yet reached that part of the world.

MINIMIZING THE TIME OF DRILLING OPERATIONS—1

ALFRED SPANGENBERG*

Rapid drilling in a shop is very necessary. It is, of course, important from the standpoint of economy in drilling, but the main feature to be considered is the fact that when work is sent to the drills, generally it is then in steady progress of manufacture, and under ordinary conditions, some of the assemblers will be found waiting for the drilling operations to be finished. The object of this article is to analyze thoroughly the elements that enter into the problem of rapid drilling and point out some of the usual defects in methods and processes.

The Machine Tool

The starting point for minimizing drilling costs naturally will begin with a discussion of the machine tool. There are several types of drilling machines, each adapted to a certain class of work. Sensitive drill presses having from one to four spindles are convenient for light work. The spindles have vertical movements by means of hand levers, and are balanced by coiled springs. The table is counterbalanced by a weight and may be swung around as well as raised and lowered. These machines drill holes up to ½ inch diameter. Besides having the advantage of high speed, the drive, which is some form of friction drive, lessens the danger of breaking drills.

The box column, high-duty type of drill press having a table of the knee type, is the best form for comparatively small work that requires extreme accuracy and is drilled without the use of drill jigs. On account of the great rigidity of this type of drill, it is particularly well adapted for the manufacture of jigs and fixtures. For this work, however, better results will be obtained by substituting a compound table so that the work remains clamped to the table until all the drilling or boring operations are completed.

Gang drills which consist of several stationary overhanging arms bolted to a common base and having a common work table are economical where several operations have to be performed on one hole. One operator usually runs the gang.

Radial drills are most convenient for handling heavy work, where a number of holes have to be drilled at different points. This type of drilling machine has a wider range of usefulness than any other, but from the very nature of its design, it is imperative that the column and arm be made unusually stiff. The amount of work that can be turned out from a modern, high-duty radial drill, when driven by a variable speed motor of ample power and using the new flat-twisted drills, is astounding. A well-built, modern radial drill meets all general requirements for accurate drilling, tapping and reaming, but when extreme accuracy is required, and when the machine is used for boring, jigs are needed to guide the tools. Universal radial drills are very handy for large work having holes to be drilled on an angle; but for angular work that can be drilled by clamping it to the swivel shelf of a box table, or where angular work is only occasionally met with, the plain radial drill is to be preferred.

I recently witnessed an interesting job that was being performed with the aid of a universal radial. The drill spindle was swiveled to a horizontal position and used to drive and feed a boring-bar that was boring some holes in a heavy vertical spindle milling machine head and column. The work was bolted to a large angle plate secured to the floor. For boring the head, the bar was guided by means of the top bracket on the milling machine column. The head was then used as a jig to bore the column. The bar in each case was driven through a universal joint. A floor drill would, of course, have handled the job to better advantage, but none being available, the universal radial performed the job in a very satisfactory manner.

Radial drills are sometimes placed in gangs and driven from a single shaft, a very good arrangement for long, heavy work. A very efficient and inexpensive horizontal drill for drilling, tapping, reaming and boring, consists of a radial drill head mounted on a vertical column. This column should

*Address: 951 W. 5th St., Plainfield, N. J.

travel in suitable guides on a base having a surface for supporting the work.

Adjustable, multiple-spindle drills are designed for drilling, simultaneously, a number of holes in groups of square, circular or other geometrical forms. The spindle heads are provided with vertical adjustment on the arms to compensate for variation in length of drills or to enable drilling to be done at different levels, the amount of this adjustment varying according to the diameter of the spindles. In setting the spindles, the work jig is bolted to the table, the drills are inserted in the jig holes and the arms are adjusted to bring the spindles into proper alignment and are then clamped. These machines are often used without the aid of drill jigs by clamping the work against suitable stops on the table. There are three standard types of multiple spindle drilling machines: 1. The smaller sizes have the head fixed on the column and

TABLE I. POWER DATA ON HIGH-SPEED STEEL FLAT TWISTED DRILLS TESTED ON POND RADIAL DRILL

Size of Drill, Inches	Peripheral Speed, Feet per Minute	Revolutions per Minute	Feed per Revolution	Number of Holes Drilled	Condition of Drill	Horse-power Consumed	Material Drilled
$1\frac{11}{32}$	150	426	0.016	9	Good	11.9	Cast iron plate, 2¾ inches thick
$1\frac{11}{32}$	185	528	0.016	30	Needed grinding	12.8	
$1\frac{11}{32}$	210	597	0.016	4	Burned off at point	17.9	
$1\frac{11}{32}$	85	241	0.016	2	Burned off at point	11.9	Machine steel, 4 inches thick
...	85	241	0.009	14	Needed grinding	7	

are provided with the knee type of table. The table is counterbalanced and its movements are controlled by adjustable hand- and foot-levers. This type is furnished with a No. 1 or No. 2 Morse taper hole in the spindles. 2. A heavier type consists of a work base having a column bolted to it. The head slides on this column and has a quick traverse by hand and power. A box table is furnished to hold small work. This is the type that takes a No. 3 Morse shank. 3. The largest size of multiple-spindle drills have a head sliding between two columns. The work table is mounted on wheels and is arranged to run on a track for bringing the work under the drills. This type is usually motor-driven and has No. 4 Morse taper holes. Any of these types may be furnished with a square, rectangular, or circular head. The spindles are all driven through universal couplings from a central gear. Power feed, automatic and positive stops are features common to all.

The value of multiple spindle drills for duplicate work manufactured in large quantities can hardly be overestimated. But for work made in lots of twelve pieces or less, it is often quite a problem to decide just what class of work this machine will handle more economically than the radial drill. This is because the time required to set the spindles of a multiple drill to a complicated layout, is an appreciable percentage of the total time required to complete the job. The layout often involves two or more settings of the work or the spindles, and this nullifying condition also enters into the problem. Provision should be made for tapping on these machines, as several holes can be tapped simultaneously.

General Requirements of Drilling Machines

Accurate tests have demonstrated that the average drilling machine should have fully double the driving power contemplated in its design. This is a point that must be considered carefully, and especially in the case of multiple-spindle drills. A proper increase in driving power means heavier motors, wider pulleys, stronger gearing and larger bearings. Immediately there follows the question of rigidity. Even at risk of reiteration, I want to emphasize the fact that ample driving power and rigidity are the vital features in a drilling machine. The fullest possibilities of economy attending the use of the new high-speed steel, flat-twisted drills cannot be realized unless these provisions are made. An idea of the amount of power required to drive these drills to their limit of endurance may be obtained from the data presented in Table I, which was obtained through tests recently made at the Pond Works of the Niles-Bement-Pond Co. It was desired to obtain power data for a 1⅜-inch drill, but as several makes of 1 11/32-inch drills were available, these were used for the test, the object being to determine the amount of driving power required by selecting for the data the drill that would stand the maximum amount of speed and feed.

The very simplest form of driving mechanism is to be preferred. Undoubtedly the best type of drive is by a direct-connected 6 to 1 speed range motor through gears and splined shafts. I have never favored a speed box for the reason that they seldom stand for any length of time the severe usage imposed upon them. The feed range of a modern drilling machine meets all general requirements. In the writer's opinion a motor never should be mounted on top of the drill column. While this is the practice with some makers, the plan is open to the practical objection that the vibration caused by unbalanced mechanical and electrical elements in the motor, becomes a serious matter, especially in machines with a long overhanging arm. This trouble will be largely overcome, however, by bolting the machine to a solid concrete foundation. On account of the high speed at which modern drilling machines are run, it is important that they be provided with self-oiling bearings and ball-thrust bearings for the spindles. A reverse for the spindle in the form of positive clutches is handy for tapping. Machines that are frequently used for drilling steel should be provided with an oil pump and pan for taking care of the cutting compound. Drill presses that have the knee type of table which is fed by a rack and pinion should be provided with an adjustable counterweight. This is to compensate for varying weights of work that are placed on the table. When this provision is not made, the work table will fall like a drop hammer when the feed is released. In the type of multiple spindle drill with the sliding head, the drive for the rapid power traverse should be through a friction. When drilling deep holes it is, of course, necessary to frequently withdraw the drills from the holes for the purpose of removing chips and with the positive-driven traverse and automatic stop, much time is lost by having to run the head

TABLE II. SPEEDS AND FEEDS FOR HIGH-SPEED STEEL FLAT TWISTED DRILLS

Material—Cast-iron			Material—Steel		
Size of Drill	Speed, Revs. per min.	Feed per Revolution	Size of Drill	Speed, Revs. per Min.	Feed per Revolution
$\frac{1}{4}$	1150	0.010	$\frac{1}{4}$	535	0.006
$\frac{1}{2}$	920	0.010	$\frac{1}{2}$	425	0.006
$\frac{3}{4}$	760	0.012	$\frac{3}{4}$	355	0.006
$\frac{7}{8}$	655	0.012	$\frac{7}{8}$	305	0.006
1	570	0.012	1	265	0.006
$1\frac{1}{8}$	510	0.016	$1\frac{1}{8}$	235	0.006
$1\frac{1}{4}$	460	0.016	$1\frac{1}{4}$	215	0.006
$1\frac{3}{8}$	415	0.016	$1\frac{3}{8}$	195	0.008
$1\frac{1}{2}$	380	0.016	$1\frac{1}{2}$	180	0.008
$1\frac{5}{8}$	350	0.020	$1\frac{5}{8}$	165	0.010
$1\frac{3}{4}$	325	0.020	$1\frac{3}{4}$	150	0.010
$1\frac{7}{8}$	305	0.020	$1\frac{7}{8}$	140	0.012
2	285	0.020	2	135	0.012

by hand past this stop. Better results would be obtained by using the friction drive and dispensing with the automatic stop. The head could then be run by power to any position, either in starting to drill or running to the bottom of the holes, without danger of breaking the drills or throwing the power traverse belt off. There would also be the added advantage of not having to run the feed by hand. Some of the smaller sizes of multiple spindle drills are not furnished with T slots in the table to clamp the work by or for use in fastening stops, on the supposition that work will not have a tendency to turn when several drills are operating simultaneously. While a majority of the work handled by these machines does not need clamping, it often happens that several operations have to be performed on a single hole, or the axes of two holes in a piece may lie at right angles, or several pieces having one hole in each may be placed side by side and drilled

simultaneously, and in each case it would be necessary to use a strap or stops for holding the work.

High-speed Drills

The new high-speed steel, flat-twisted drills have been the most potent factor in reducing drilling costs. It is astonishing to note, however, that the tremendous enthusiasm attending their use is often confined to the primary installation; after that the drills are run far below the proper point of speed and feed and the ultimate increase in efficiency instead of being fully 300 per cent or more over that obtained with the older carbon drills, is nearer 50 per cent. Soon the important matter is lost sight of and the only real knowledge the firm possesses on the subject is that "We are buying and using regularly such-and-such a make of high-speed steel drills." In view of the lack of accurate information relative to the proper amount of speed and feed for the new high-speed steel flat-twisted drills, Table II will prove interesting. The results shown may not, in all points, prove to be the limit of speed and feed, but are far in excess of those usually secured, so that they can be safely used as a basis upon which to work.

Many manufacturers of high-speed drills lay great stress on the length of time their drills will run without regrinding. This, however, is of very little importance, as the question is not how long a drill will run without regrinding, but how much should a drill be forced so as to produce the most work with a minimum expense for grinding. The crowding of the drilling machine is the important consideration. The question of how long a drill may run without regrinding sinks into the background when the grinding is done by automatic grinders. It is important to state in this connection that a large supply of drills already ground should be kept in the tool supply room, so that under no circumstances will the drill hands be compelled to wait for their drills. This important point is often overlooked. When drilling steel, the use of cooling agents, such as soft soap is highly desirable. These should be used very freely.

TABLE III. COMPARISON OF STANDARDS FOR TAPER SHANKS ON DRILLS

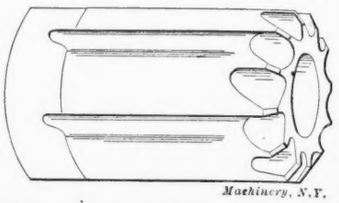
Drill Makers' Standard for Taper Shanks		Pond Standard for Taper Shanks	
Size of Drill	Taper on Shank	Size of Drill	Taper on Shank
1/4 to 19/32	No. 1 Morse taper	3/16 to 31/64	No. 1 Morse taper
5/8 to 29/32	No. 2 Morse taper	1/2 to 45/64	No. 2 Morse taper
15/16 to 1 1/4	No. 3 Morse taper	25/32 to 63/64	No. 3 Morse taper
1 9/32 to 2	No. 4 Morse taper	1 to 1 13/16	No. 4 Morse taper
.....	.....	1 7/8 up	No. 5 Morse taper

Miscellaneous Tools

The new sockets for driving drills and other tools with broken or twisted tangs have saved these tools from the scrap heap. Before these sockets were introduced, many firms avoided the trouble by ordering their tools with taper shanks larger than standard. In fact, this is just what the new sockets do—provide the tools with the next larger size of shank. Table III shows the standard adopted by the Pond Machine Tool Co. and also the drill maker's standard for taper drill shanks.

Whenever possible, tapping should be done in a machine on account of the time saved. Some form of safety tapping device will prevent the danger of breaking the taps. For tapping several holes simultaneously in a multiple spindle drill, when the holes are close together, these safety tapping fixtures cannot be used on account of their large diameter. In this case, ordinary tap-holders having a square hole to fit hand taps are used. The tap holder should be provided with a spring pin to keep the tap from dropping out. A plug tap is generally used for machine tapping in cast iron. For steel, the hole is drilled 1/64 larger than standard and two taps are used.

Rose reamers are very extensively used for reaming holes in jig work. These reamers have no cutting edges on the lands, and so permit the reamer to be guided in a cast-iron bushing. Inasmuch as the size is not adjustable it is essential that the wear of a rose reamer be reduced to the lowest limit, in order to ream a large number of holes of a uniform size. The standard form for rose reamers, as made by a number of manufacturers, is illustrated herewith. A study of the engraving will reveal the fact that it would be a decided improvement to cut all the flutes the entire length of the body. When made in the form shown there is no escape for the chips cut by the edge of the short flutes, especially when reaming to the bottom of a blind hole. The result is that the lands are soon cut and make a rough hole. Experiments and experience prove that a rose reamer having all the flutes cut the entire length and provided with a sufficient number to make the lands about 1/4 inch wide will outwear the other form 3 to 1.



Machinery, N.Y.

Fig. 1. Standard Rose Shell Reamer—Life is Prolonged and Smooth Holes Result by cutting all Flutes entire Length of Body, enabling the Chips to Escape

All boring cutters and counterbore cutters should be made of high-speed steel.

The question of jigs naturally will come under the subject of tools. The great value of jigs as a factor in reducing drilling costs is so well recognized, however, and the subject has been so thoroughly threshed out in a series of articles recently published in MACHINERY, that no further comment is necessary.

* * *

DOES EDUCATION PAY?

W. L. CHENEY*

Does education pay? In the higher sense, yes; but from a financial standpoint it does not always pay its possessor.

The kind of education under consideration is an acquired mental equipment that enables its possessor to think more clearly and correctly than he naturally would. This may be acquired by thinking, and hence it is possible for a man to be wholly self-educated. The quicker and usual way is to study what previous thinkers have put on record, *i. e.*, "the books"; but when books are used blindly, and accepted as rules of thought or conduct, instead of as assistants to thought, they become a hindrance rather than a help.

All progress is the result of education; therefore education is good—so good and grand and fine that it should not be prostituted to commercialism. I therefore protest against certain advertising that is much in evidence, and which would be more appropriate to "Somefeller's Bitters" than to education.

Men are not paid for what they *know* but for what they *do*. If an education enables its possessor to do more or better things, it will, *other things being equal*, increase his money *earning* capacity in direct proportion (and it might decrease his money-*making* capacity—but that is another story).

However, other things are *not* equal, and two other factors must enter into the calculation. First, the number of men who have the same education; and, second, the demand for services that the educated men can render.

In consequence of these other factors, sometimes the man who comes out of the "other" door, or is on the "other" side of the desk, gets more money for his services. One door and one side of the desk cannot exist without the other, and both are therefore equally necessary and, in consequence, equally honorable, and should not be pictured otherwise.

The sort of advertising in question contains not only the possibility of raising false hopes, but also of promoting wrong and snobbish ideas and adding to class feeling, of which some people think there is already too much.

* * *

The Third Avenue Railroad Co. of New York has ordered experimental cars of two kinds to be placed in service with a view of supplanting the horse cars now in use on branch lines. One of the experimental cars will be a gasoline electric having a gasoline engine driving the dynamo which operates the car through the motors direct or by charging a storage battery. The other car will be of the pure storage battery type.

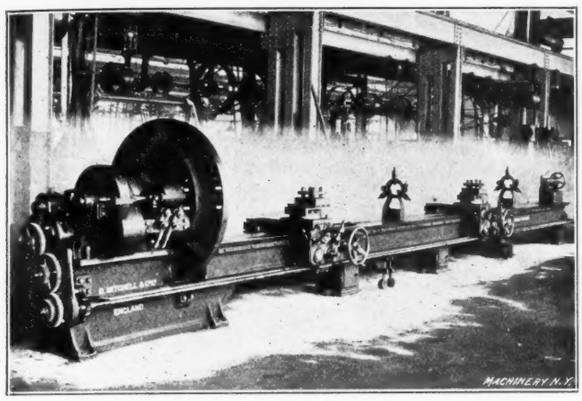
* Address: Meriden, Conn.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

A KINK IN PHOTOGRAPHY

Some time ago I had to take a photograph of the lathe shown herewith. This lathe has a 28-inch swing and a 36-foot bed, and in one particular it is rather out of the ordinary. Normally, there are two complete lathes on the one bed, the headstocks being at the extreme ends and the tailstocks in the middle. One operator is at the back of the machine and one at the front, as usual. The rear lathe has a lead-screw and feed-shaft slightly less than half the length of the bed, while in front, as will be seen from the photograph, the lead-screw and feed-shaft extend along the whole length. The



The White Background for this Large Lathe was obtained by moving a Small Sheet from One End to the Other during Exposure

novelty of the arrangement is that the carriage belonging to the rear lathe can be turned around to the front so that both carriages may be at work on the same job, one headstock and one tailstock being, of course, removed. Normally, however, the machine is worked as two independent lathes and as such was photographed by me and also by a professional photographer whom we generally employed when we wanted an extra good job.

Anyone who has tried to block out a negative of a machine which has the shop for a background, knows that it is a difficult matter to tell which is the machine and which is the shop. It is always advisable to have a white sheet for a background so that the outline of the machine is easily discernible; in fact, the writer has taken scores of machines where no blocking out was necessary at all. The white sheet should be gently swayed during exposure in order to remove all creases and dirty marks which would show if the sheet were still. This method is a good one to adopt if a large enough sheet is available; it is hardly practicable, however, to have a sheet big enough for a 36-foot lathe. The only thing then that can be done is to rig up a background that will enable the blocking out of the negative to be done more easily.

When the first photograph of the lathe was taken, a large sheet was suspended from the crane. This was made of a lot of white paper fixed up on cords very much like the family washing, and, in addition, a smaller sheet was held up by three men. It took about an hour to get the background fixed, so after once dismantling it (this was necessary in order to run the machine) I didn't like the idea of putting it all up again to take the other view; consequently I thought I would only use the small sheet, but instead of keeping it in one position, have the men who were to hold it walk from end to end of the machine during the exposure. This was done, and, as will be seen from the reproduction (which has not been retouched in any way) the idea was a success. It leaves the outlines of the machine well defined, and no time was required in putting up a background.

For all practical purposes, it is unnecessary to block this negative out, as the girder work, counter-shafts, etc., rather improve the appearance of the picture, besides giving some idea of the size of the machine. If, however, a pure white background is essential, the negative must be blocked out; this can be much more easily done when a background is used.

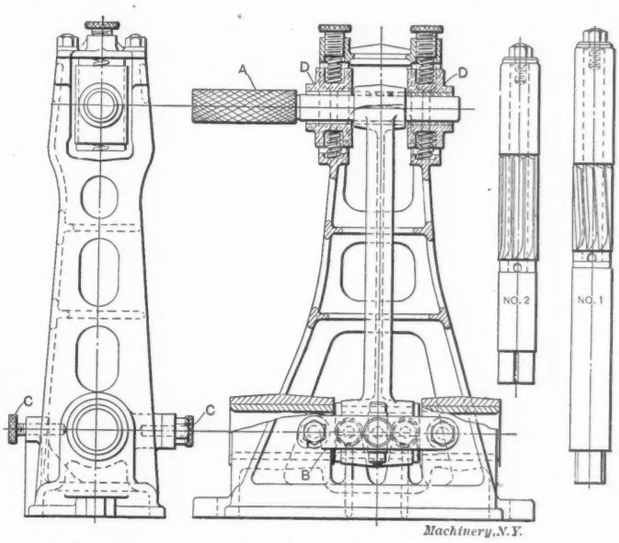
ALBERT CLEGG.

Keighley, England.

FIXTURE FOR REAMING CONNECTING-ROD BEARINGS

The jig and tools shown herewith were designed for the purpose of eliminating, as far as possible, what I once heard a manufacturer call "a slow, money-eating process"—that of scraping. We began finishing the bearings of a lot of gasoline engine connecting-rods by first reaming with a standard hand reamer and then scraping them to a good bearing and running fit. This proved to be a slow method, for the connecting-rod bearings were so short that there was difficulty in starting the reamer straight, and it was also liable to chatter, which necessitated a great deal of scraping and bending to make the wrist and crank-pin bearings parallel. The jig referred to was first designed with the wrist-pin end solid, but this proved unsatisfactory as some of the rods had not been machined as accurately as a solid jig would require. To overcome this difficulty the jig was re-designed, and movable brass boxes *D* and springs were used. After this the jig worked satisfactorily and gave a variation of about six-thousandths of an inch, this being the limit allowed by the maker.

The connecting-rod was placed in the jig and held by the pin *A* and the pilot of the line reamer number 1. Then gate *B* was closed and the set-screws *C* locked against the rod to relieve any side strains or tendency the springs might have to pull when reaming. After this the reamer was run through



Fixture designed to ream Bearings Smooth and Parallel and thus Eliminate Scraping

the box reaming it to 0.002 inch below size. After this operation the rod was removed and reamed by the standard size reamer number 2. This method was found to be a satisfactory one, giving a true bearing which could be fitted with but little scraping (most of which had to be done upon the fillets) besides making the wrist and crank-pin bearings practically parallel.

In fitting connecting-rod bearings I have found that babbitt bearings will wear longer by being fitted as closely as a good running fit will permit. On the other hand, I find that when using bronze it has proved better to make them a thousandth larger than the journal. If fitted closely they are inclined to seize, after which they pound quickly. For the process of scraping we found that a three-cornered file ground to the proper edge was one of the most satisfactory scrapers that could be made. It is a comparatively easy matter to hold the bearing in the hand and scrape it, whereas with a half-

round scraper, such as is customarily used, it is necessary to use a vise to hold the box and both hands to manipulate the scraper.

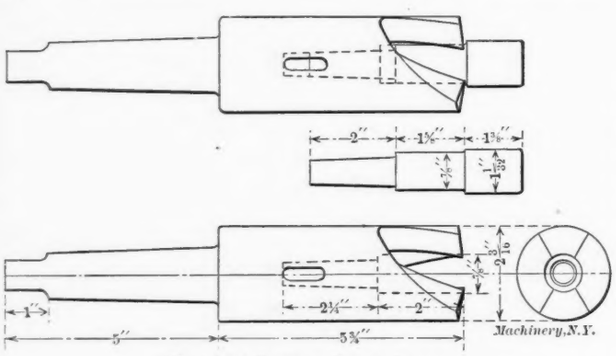
A box wrench should be used, when possible, for tightening the connecting-rod nuts. While this may seem a small matter, one has only to stand for a few minutes and watch a man with a clumsy monkey-wrench to see that the workman with a box wrench can not only do a much quicker and better job in tightening the nut, but does not bruise it during the operation—a consideration which amounts to quite a good deal on a finished product.

Salem, Mass. JOHN F. WINCHESTER.

FLUE-HOLE CUTTER OR COUNTERBORE

A special tool for the drill press, used in cutting the flue holes in the flue sheets of boilers is shown in the engraving. This tool is of tool steel and is made the size of the flue hole. The center hole is bored and tapered to fit a Morse No. 2 taper, and the center piece or guide shown, which is also of tool steel, is then turned and fitted. The jaws are next milled, and then both the tool and the center guide are hardened and ground to the exact size, clearance being given to the cutting edges.

The flue sheets to be drilled are first laid off, centered, and one-inch holes punched. They are then taken to a radial drill press and the holes are reamed out with a one and one-



Flue-sheet Cutter or Counterbore

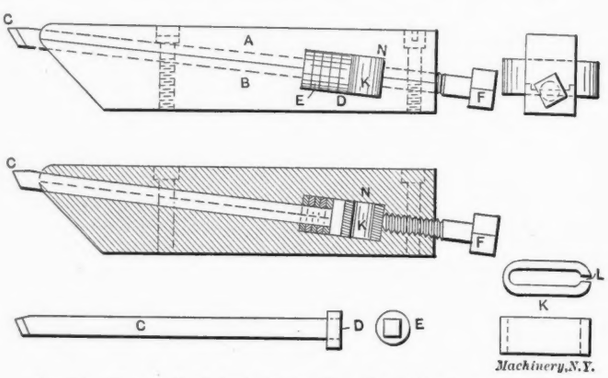
sixteenth inch drill, which takes only a short time and leaves a clean round hole for the center guide to work in. The tool illustrated herewith is then put in the drill press and used as a drill, the center guide being placed in the holes already made. The center guide pin is made removable so that the edges of the cutter can be ground easily, and also extends over the inner edge of the cutters, which makes the tool work very evenly. This cutter has been used in the D. & I. R. shops at Two Harbors, Minn., and its work is satisfactory.

Two Harbors, Minn. AUSTIN G. JOHNSON.

PRECISION THREAD TOOL

Every toolmaker and machinist knows the difficulties often encountered in cutting screw threads of even ordinary accuracy, owing to the tendency of the thread tool to leave chatter marks, especially on large work where the steel is very soft. The goose-neck thread tool of old has gladdened more than one weary heart, only to sadden it again when the work reached the inspector, for I believe that while this tool will make a smooth and very beautiful appearing thread to the casual observer, it is impossible to make an accurate thread with it, or anything like a thread that a nut can be fitted to so that it will not speedily become loose if used a few times. This is caused by the springing of the tool into and out of the metal being cut, as well as sidewise, distorting the thread angles, and causing variations in the depth of the thread so that when a nut is fitted to this thread the high spots soon wear away. With all of its imperfections, however, the goose-neck tool is extensively used, as it will do fine looking work much quicker than the ordinary straight, rigid tool. The toolmaker, however, is often confronted with work which must not only look well, but must be done quickly and accurately, and then he is filled with a longing for a better tool with which to do the work.

I think it is safe to say that steel cannot be made, or at least has not yet been made, so that it is of exactly the same consistency all the way through from end to end. There are places near together where the metal is either softer or harder than the average, the difference being very slight, yet existent. Then there is the imperfect lathe, made as perfect as man is capable of making it, yet to the toolmaker there are observable plenty of signs of wabbling and winking, on the best makes of lathes—small it is true, but nevertheless there—that combine with the more or less imperfect steel to make the toolmakers hair grow white while he is still young.



Precision Thread Tool designed to allow the Cutter to spring away from the Hard Spots

In the effort to better conditions in my own practice, some time ago I designed and made the thread tool shown in the sketches herewith. I do not claim that it is so perfect that it will overcome *all* the troubles of those who make an effort to cut ideal threads, but I do claim that an approximately perfect thread can be made more expeditiously with it than with any tool of its class I know of, and the thread will be as smooth and pleasing to the eye as the very best work done with a goose-neck tool. The accompanying illustration shows the construction of the tool. The cutter-blade *C* is made of a piece of self-hardening steel, which is ground on the surface grinder as nearly square as possible, and then lapped to exactness. On its rear end is a collar *D* which is made of machine steel and shrunk on. The otner end is carefully ground to the angle of the thread to be cut. To hold this cutter in the tool-post of the lathe, two pieces, *A* and *B*, of machine steel are milled, grooves being cut in both the top and bottom pieces as represented by the dotted lines, so that the cutter-blade will be held between them. They are also made to interlock as shown in the end view. These cutter grooves should be made so that the blade will fit perfectly, and yet allow it to move rather freely longitudinally. Four screws hold *A* and *B* together, two on each side of the blade, and at opposite ends. A rectangular slot *N* is cut through the tool transversely, one-half of this slot being in the part *A*, while the lower half is in the part *B*. All of the work should be accurately done, as it will pay in a tool of this class to make it as perfect as possible in order to get corresponding results. A hole is drilled and tapped in a line axially, with the cutter groove, for the set-screw *F*. In the slot *N*, there are five washers *E* which are strung on the cutter-bar before it is finally inserted in the holder. The purpose of these washers is to allow the cutter-bar to be advanced as it is ground off, from time to time. A rectangular spring *K* having a slot *L* in one end is placed in the slot *N* behind the head *D* of the cutter. A core made of whitewood and slightly smaller than the interior of the spring is inserted within it. The assembly now being complete it will be seen that the cutter-bar *C* is free to slide back in the groove in the holder so far as the spring *K* will allow it, the pressure of the spring against the cutter-bar being adjusted by the set-screw *F*.

As before mentioned, the old goose-neck tool is free to spring into as well as away from the work, and it is also free to spring sidewise. It will also spring while taking the finishing cut as well as when roughing, which is fatal to accurate results. From the extensive experience I have had with the tool herewith shown, it appears that to cut a

smooth thread, it is only necessary to allow the point to spring *away* from the harder spots in the steel and to prevent the cutting point from digging into the softer part after it has passed the hard. I usually take the roughing cut on small work with the set-screw *F*, slackened so that the slot *L* in the spring *K* is well opened, and when I am ready to finish, I turn the set-screw up until the whitewood core is gripped by the spring. For roughing large work the ordinary goose-neck tool may be used, but care must be taken not to take off too much, as work done with this tool is deceptive, and where accuracy is required it may dig in so deep that when an attempt is made to finish with this new tool it will be found that in places it will not touch the thread made by the goose-neck roughing tool. When properly made there is no chance for side movement of the cutter-bar *C*, in the holder *A-B*, and the resulting thread angles are as perfect as they are ground on the cutter and as the various imperfections of the lathe will allow.

Newark, N. J. G. J. MURDOCK.

JIG FOR DRILLING SLOTS

There are many details in machine construction that require an oblong slot. This work can be readily done with an ordinary slot milling machine when the width of the slot is great enough to permit the use of a stiff cutter; but a slot or other milling machine is not always available, in which case the jig described in the following will be found an excellent substitute. In fact, for doing such work as cutting spring cotter slots in the valves shown in Fig. 1, milling cutters are too weak to withstand more than a slight cutting pressure sideways, as the slots are only about 1/16 or 3/32

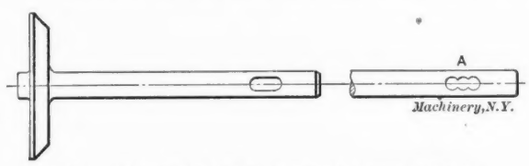


Fig. 1. Oblong Slot drilled in the Jig shown in Fig. 2

inch in width. A drill of this size, however, will cut very rapidly with a direct vertical pressure. In Fig. 2 a jig for drilling these slots is shown with the valve stem in position. The stem is held in place by the set-screw *C*. The two holes *A*, which are 3/16 inch apart, are first drilled in the stem, after which the jig is turned over and the hole *B*, which is central with the holes *A* is drilled, which produces a slot as shown at *A* in Fig. 1. As will be seen, there is very little

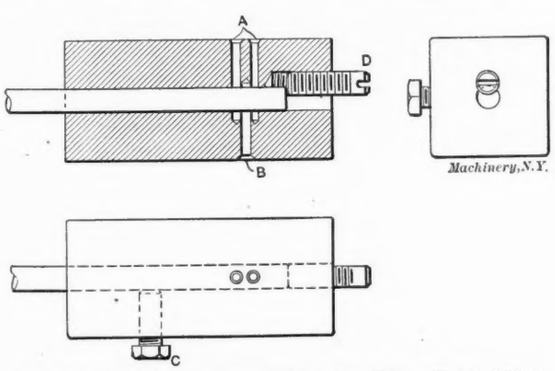


Fig. 2. Jig in which the Central Hole of an Oblong Slot is drilled from the Opposite Side

metal to remove in order to obtain a smooth slot. This is accomplished with the drift shown in Fig. 3, the end of which is turned to a sliding fit for a 3/32 inch hole. This end acts as a guide or pilot to the cutting teeth. The number of teeth in this broach should be sufficient to allow a very slight amount of metal to be removed by each tooth. The drawing is shown on an enlarged scale in order that the construction may be better understood. The teeth on the sides of the broach are inclined in opposite directions in order to counterbalance the thrust endwise. Of course, if the teeth on both sides were inclined in the same direction the broach when driven through the slot would tend to bind against one end of the latter. As will be seen in Fig. 2, the valve stem is located in the jig by the adjustable screw *D*. Only part of the full area of the end of this screw comes into contact with the end of the stem to be drilled. This provides an opening through which any dirt or chips which may be in the hole when the stem is inserted, may pass out. This opening also allows a punch to be inserted for the purpose of driving the valve back when the holes have been drilled.

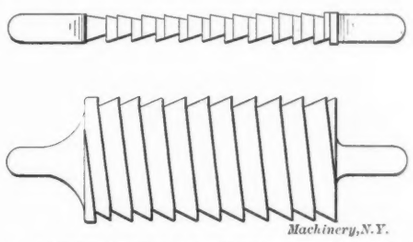
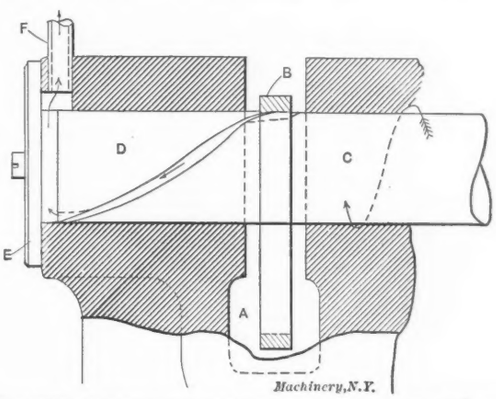


Fig. 3. Enlarged View of the Broach for Finishing the Slots

If a blind hole were used it would be quite difficult to remove the chips, with the result that the holes in the stem would be drilled in the wrong position. By referring to the sectional view of the jig it will be seen that the holes for guiding the drill are extended a little way into the opposite half; this is done in order that the drill may pass clear through the stem. CONTRIBUTOR.

FORCED LUBRICATION

An ingenious and simple method of continuous and forced lubrication, which has given complete satisfaction for the purpose intended, is shown by the line drawing. In many respects it is similar to the usual ring oiling bearing, but an important difference consists in utilizing a spiral groove for forcing oil to another bearing which could not be reached by



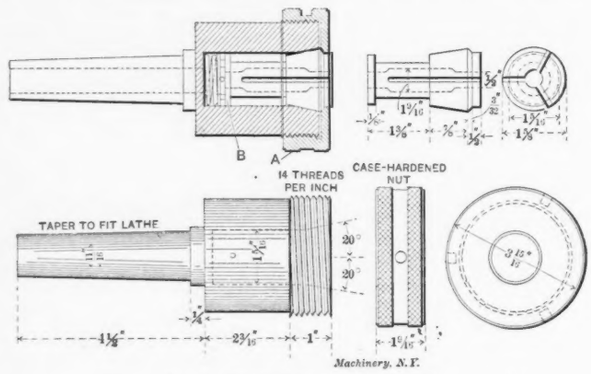
Ring Oiling Bearing arranged to force the Oil to another Bearing

a ring oiler, and for which a liberal supply of oil was necessary. Referring to the drawing, *A* is an oil reservoir; *B* a loose ring on the shaft *C*; *D* a spiral groove cut in the shaft; *E* a plate covering the end of the bearing; and *F* a pipe through which the oil is forced to the other bearing (not shown). The shaft revolves at a high speed, and the ring *B* carries oil from the reservoir to the shaft. Some of this oil is deposited in the groove *D*, and, owing to its inertia and the angle of the groove, the oil is forced along the groove into the chamber at the end of the shaft, and up the pipe *F* as shown by the arrows. When trying this in its initial stages, it was an easy matter to force the oil 3 feet above the shaft. OILER.

IMPROVED LATHE CHUCK

Many of the standard bench lathe chucks on the market present the disadvantage of having a very short gripping surface; it is also difficult, at times, to release the work from the draw-in chuck without tapping on the hand-wheel. When the rear end of the collet has a larger hole than the front, the work is also constantly tossing about. The accompanying drawing shows the construction of a lathe chuck which is designed to remedy these troubles. This chuck was especially built to hold drill rods from 3/16 to 5/8 inch in diameter. The

body is made of tool steel. The taper shank should first be fitted to the lathe in which the chuck is to be used, so that the latter may be inserted in the spindle and finished. The nut *A* is made of machine steel and case-hardened. It may be turned with a spanner wrench, holes being provided as shown. Collets of the required size are made of tool steel and hardened. The rear end of the collets have the same size holes as the front, so as to prevent the work from being tossed about. A spring is inserted in the body of the chuck, which is held in position by a flanged collar *B*, which, in turn, is



Chuck with Spring-actuated Collet

retained by dowel pins. When the collet is in position, it is forced against the collar and spring by nut *A*. When this nut is released the spring forces the collet out and thus releases the work, which can be removed without trouble. These collets should be tempered so that the center is as soft as possible to prevent their being easily broken. As will be seen by referring to the illustration, this chuck can be made in almost any shop without the use of special tools.

Washington, D. C. H. D. CHAPMAN.

A GAGE FOR CENTERING WORK WITH MILLING CUTTERS

The accompanying drawing shows a handy tool for milling machine work, such as milling keyways and gears. One method of setting the work central with the cutter is to place a square on the table of the machine with the blade in contact with the work, and caliper between the upper end of the blade and the cutter first on one side and then on the other. The cutter is, of course, central when the caliper reads the same on both sides. The method of dial reading is also used.

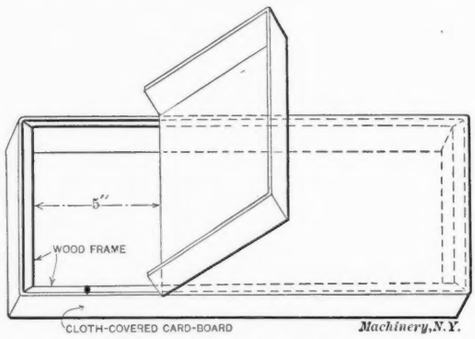
I made this micrometer attachment for such work. Place the base *A* against the cutter as shown in the engraving. Move the arm *B*, which swivels at pivot *C*, so that the point *D* of the micrometer screw nearly touches the work; then adjust the micrometer until the point touches the work and take the reading. Use the tool on the other side of the cutter in the same way and adjust the work until the micrometer shows the same reading on each side. This tool is also handy for leveling work on grinders or planers, where accuracy is desired. H. D. CHAPMAN.

Washington, D. C.

SIZE OF WORKING DRAWINGS

In commenting on Mr. Breath's article advocating the use of several small sheets for detailing one part, Mr. Washburn in the May number of MACHINERY makes some very strong points against such practice.

We started some time ago to reduce our large sheets containing numerous details to individual sheets of small size. Three sizes were adopted: 14 x 18 inches; 9 x 14 inches; and 7 x 9 inches; and the size which gives the best results as to clearness of outline is used. Occasionally it has been necessary to put three views on separate sheets, in which case we paste the blue-prints together on one sheet for shop use. The views, however, were all detailed (in pencil) on one sheet and projected as usual, only becoming separate when traced. Repetition of dimensions is avoided by a note which reads:



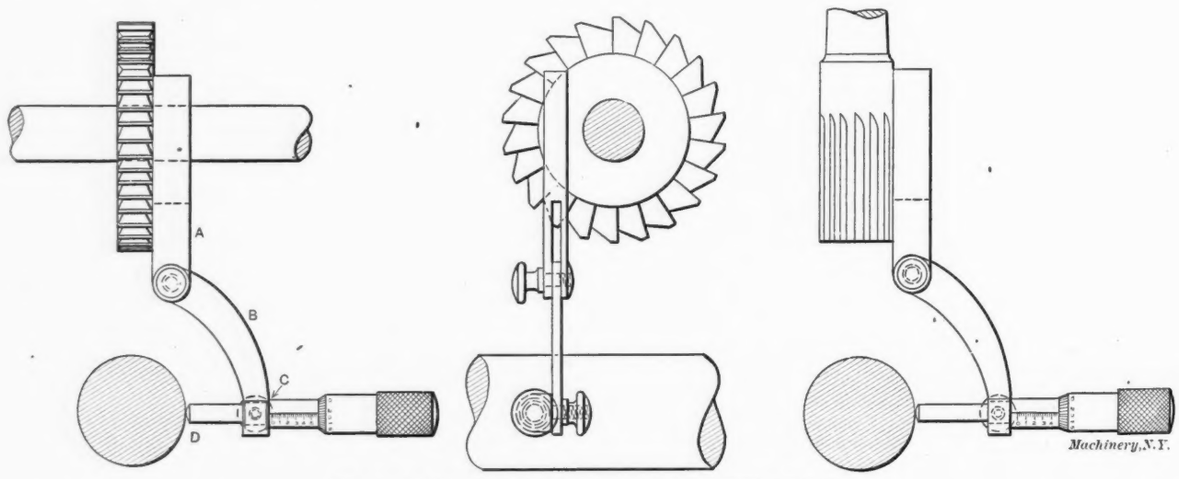
Portfolio in which the Drawings are Filed

"For other dimensions see sheet number — and number —." This note is placed on each view with the proper numbers added. In this way we have met the objections mentioned by Mr. Washburn.

We do not designate the size of the sheet by any symbol, but have assigned certain blocks of numbers—enough to last some years—to each size, which allows each size to be filed numerically, as the numbers are assigned serially and placed on corners of the tracing. In place of the envelope, which is liable to tear if frequently used, we used a portfolio which is illustrated in the engraving. These boxes each hold one hundred sheets and they are made in three sizes to fit the drawings.

The box has a framework of metal or wood which prevents it from being crushed or broken, and it is covered with cloth-covered card-board. Any first-class box factory will make these portfolios at a reasonable figure, and they will last for years. RALPH W. DAVIS.

Rochester, N. Y.

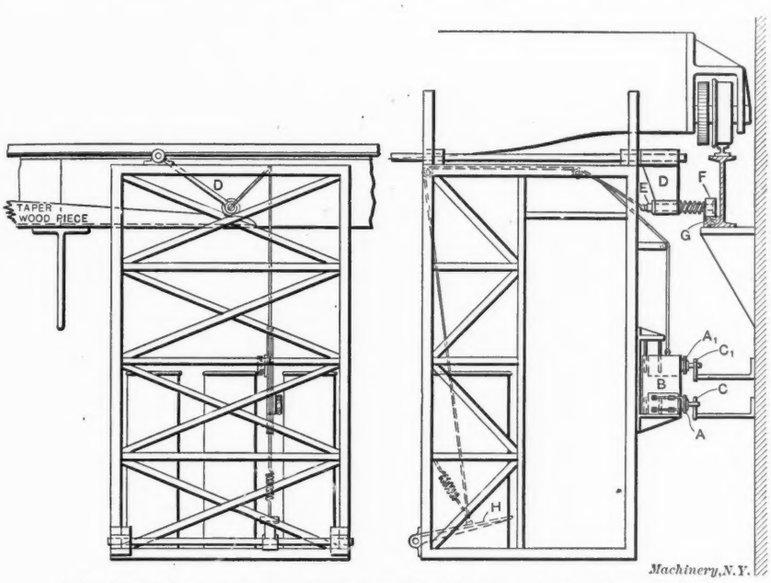


Micrometer Gage for Setting Work Central with Milling Cutters

SAFETY DEVICE FOR ELECTRIC CRANES

I ran across a safety device the other day for automatically stopping the bridge travel of the electric cranes, which seemed meritorious to me. At least, it possesses the virtue of originality. It was not the product of a mechanical engineer, nor did it have its conception in the brain of an electrical wizard. It is just a plain, simple, practical affair without the "frills and furbelows" of electric brakes, circuit breakers, etc. However, from what I know of the device, I am not sure but that I would trust to its operation in preference to any other with which I am familiar. It consists, primarily, of two positive, quick-breaking switches (one operating in either direction to cut out the power from the bridge travel); and an automatic device for applying the friction brake, to overcome the momentum of the crane and to bring it to a stop at any desired point.

Referring to the accompanying illustration, A and A_1 represent the cut-out switches which are fastened to a wooden piece B, about 8 inches wide by 12 inches long, located at the back of the operator's cage. Trips C and C_1 are arranged at the proper points along the wall to trip their respective switches as the crane passes them. An arm or lever D is attached to the extended end of the friction brake shaft. The outer end of this lever carries a stud E upon which is mounted a roller F. A tapered piece of hard wood G is secured to the I-beam at each end of the travel of the crane. The length and degree of taper of these pieces are regulated by local conditions. When the crane reaches the danger points, at which places the trips are located, C or C_1, as the case may be, knocks out its respective switch, and the roller F begins to ascend the incline of the piece G, in consequence of which the friction brake is gradually applied, and the crane is brought to a gentle stop.



A Safety Device for Automatically Stopping Electric Cranes by Breaking the Power Current and Applying the Brake

If it is necessary to pass the danger points, the operator presses the foot-lever H, which, through the medium of a small wire cable, raises the piece B carrying the switches, and allows the latter to pass over the trips. The same operation of the foot-lever withdraws the stud E through the arm D, and the roller F passes in front of the tapered piece G, instead of running up the incline. This leaves the crane in normal condition, free to be operated in either direction as though no safety device existed. While in the danger zones it is not necessary for the operator to keep the foot-lever depressed, as it may be released as soon as the trips C and C_1 are passed, for then the roller F cannot resume its normal position, but will slide along the face of the tapered piece G until the crane has been reversed and passes out of the danger zone. In leaving the danger zone, the spring on the stud E forces the roller F back into its normal position. The trips C and C_1 are hinged to move in one direction only, thus allowing the crane to pass out of the danger zones without interfering with the switches.

A telltale light is hung in the cage and lights a few feet in advance of where the trips operate, so that the operator knows when to depress the foot-lever if he desires to enter the danger zones.

The distance in which a crane can be stopped, and the consequent length of the danger zones, are, of course, dependent upon such conditions as the size and weight of the crane, the traveling speed, and the efficiency of the friction brake; but to give an idea of what these may be, the crane upon which this device is in operation is one of 20,000 pounds capacity, with a span of about 45 feet, and running at full speed from one end of the building to the other, is brought to a stop in from six to eight feet after the power is cut off.

Cincinnati, O. J. F. MIRRIELEES.

TOOL-ROOM CHECK SYSTEM

In the March issue of MACHINERY Mr. George D. Hadun has something to say in regard to tool-room check systems. In my wandering about I have found that most of the shops have the check system which Mr. Hadun abandoned; that is, the system in which each man has a number of checks in his own keeping and when a tool is wanted a check is given for it and placed where the tool is kept. The shop in which I am employed has the same system and we also find that it is very unsatisfactory. Very often the men are charged with tools they haven't seen, and, then again, others get possession of tools somehow without a check and refuse to turn them in—then, of course, there is trouble.

Mr. Charles Dodd, tool-room foreman of a well-known shop employing about 250 mechanics in one department, informs me that he has an addition to this system which has proved helpful. A number of checks stamped from one to thirty-one and of a different shape than the other checks, are kept in separate boxes in a drawer and used for each date of the month; they are used for the finer tools only, such as standard plugs, etc. When a man gets a standard plug, for instance, his check is placed on the pin where the tool is kept, and a check with the date of the month is also placed on the same pin, thus showing what day the tool was taken. At the end of the month if the tool is still out, the man having it is looked up and if he still wishes to use the tool, he must first return it to the tool-room; another check is then put on the pin showing that the tool was taken again on the first of the month. By this method the tool-room foreman knows where the tools are on any date of the month, and how long they have been out. No trouble has been experienced with this part of the system thus far.

Mr. Dodd has in mind a system that is a little different from the ordinary, which I think is worthy of a trial. Each man has a number of checks in his own keeping, as before. A check of different shape, with the name and size of tool stamped on, is placed on a pin near each tool on the shelf or in the drawer. When a man calls for a tool, he gives his check, and, in return, receives in addition to the tool, the check with the name and size of tool on it; it is really an exchange of checks. This system would tend to prevent the men or boys who give out the tools, from placing the wrong check on the peg of some missing tool and holding the wrong man responsible for it, because the man who has the tool also has the check to show for it; furthermore the men sometimes forget what tools they have out on check, either by lending or misplacing them, and in such a case the check with the name and size of tool on, would be a reminder. [The system advocated in the foregoing, in which there is an exchange of checks, is in use and is, as far as we know, satisfactory.—Editor.]

A neat way of arranging small emery wheels that are let

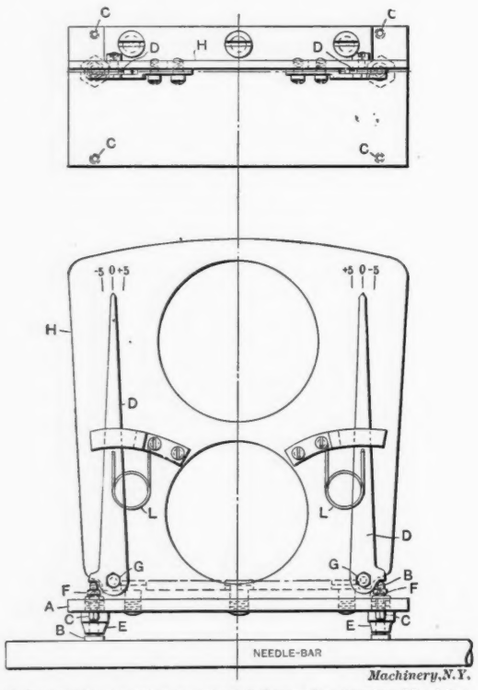
out on check is to have the pin on which they are kept in the drawer turned smaller at the top end to fit the hole in the check; when the wheel is taken off the peg the check is slipped on the end of the pin so that when the wheel is returned it cannot be put in place unless the check is first taken off.

A. J. DE LILLE.

Elgin, Ill.

A SPECIAL INDICATOR

In one type of shoe sewing machine there is a needle-bar which has besides its endwise motion a swinging motion sidewise through a small arc. For each stitch the bar makes a full advance, a slight return to loop the thread, a full advance and a full return; during this time it also makes one lateral motion. Aside from time, the chief requisite is exact alignment, or that the bar shall be at all times parallel with the base, which lies in a horizontal plane. The inspectors found in some machines that this bar did not swing parallel with



Indicator for Testing the Parallelism of a Sewing Machine Needle-bar with the Frame

the frame, and a special indicator was needed which would show at once such error.

After sketches had been made of two or three designs, the indicator illustrated herewith was made. The steel base *A* rests on four feet *C*, which were hardened and then ground and lapped into the same plane. When the indicator is in use, these feet rest upon the frame of the machine. The hardened tool steel plungers *B*, which come into contact with the needle-bar, are flat on one end and spherical on the other, as shown. These plungers fit loosely into the bearings *E*, and are held from dropping out by the nuts *F* which are adjusted to allow sufficient rise and fall. The bearings *E* are of such a length as to give a slight clearance when the plungers are raised as high as they will be when the indicator is in use. Fulcrumed on the studs *G* are the pointers *D*, which have small hardened projecting arms which are in contact with the upper ends of the plungers *B*. The frame *H*, which is of sheet steel, is bent at a right angle along the bottom and screwed onto the base. Right and left coiled springs *L* act in opposition to the plungers and return the pointers to their extreme outward positions. A description of how these springs were made right and left without winding twice may be of interest. A short section of spring was first wound, and then cut into two pieces. The end of one of these sections was bent through it axially and grasped with pliers, while the other end was also held with pliers; the spring was then easily reversed by simply pulling the end through quickly. When the pointers were to be adjusted, the instrument was set on parallels, a height gage inserted under each of the plungers, successively, and the rounded ends of these stoned off until at the same setting each pointer stood at the zero mark. The figures + 5 0 — 5 indicate thousandths of an inch. When completed this tool proved very satisfactory.

H. V. PURMAN.

Winchester, Mass.

RECORDING BOARD TO KEEP TRACK OF THE BELT LACER

A recording board for keeping track of the belt lacer is shown in the illustrations. We have a man who does nothing but attend to belts, and formerly there was a lot of time wasted in trying to find this man, so a board was provided which indicates the department in which the belt lacer is at work, and also tells him the number of the department in which he is wanted. This board has thirty holes at the top, as shown in Fig. 1, each having a number corresponding to a department. Below these holes there are additional holes containing six black pegs and fifteen red ones. When the belt lacer is wanted, one of the red pegs (which have numbers painted on them from 1 to 15) is put in the hole at the top, which has the correct department number. Then when the belt lacer looks at the board he knows in which department he is wanted; but before leaving he takes out the red peg and puts in a black one. By having the pegs numbered the lacer knows where to go first; the men also know just what department he is in by observing the number of the hole in which the black peg is inserted, so that he may be called in case of emergency. The board is kept in a central location, and it is a case of "First

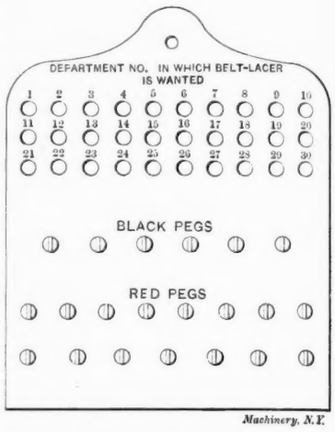

DEPARTMENT NO. IN WHICH BELT-LACER IS WANTED
1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30
BLACK PEGS
RED PEGS
Machinery, N.Y.

Fig. 1. Board which gives the number of the Department in which the Belt-lacer is at Work, and also Indicates where he is wanted

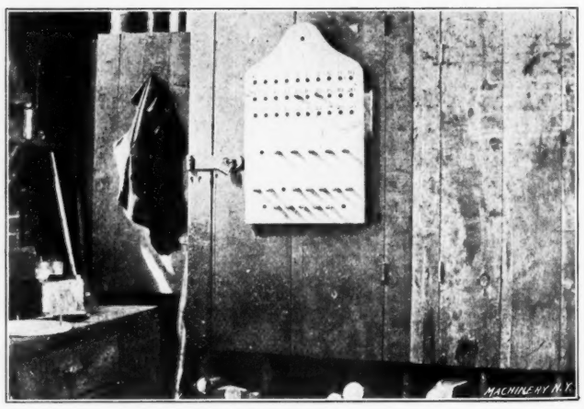


Fig. 2. View of the Recording Board, which hangs in a Central Location

come, first served"; whereas by the old way the first man lucky enough to find the belt lacer would get his belt laced first.

F. TERRY.

West Toronto, Canada.

BENDING DIE FOR ARMATURE BAR CLIPS

The article in the January issue of MACHINERY entitled "Bending Die" was very interesting to me, and I thought possibly my way of doing the same work might be of interest to others. Some years ago I was called upon to design tools for blanking and forming armature bar clips. The pieces are first blanked as shown at *A*, Fig. 1, in a tandem punch and die, which is so simple that it need not be described. The first operaton of U-bending, as shown at *B*, Fig. 1, is done

by the forming or bending die illustrated in Fig. 2. This tool has replaced 37 formers of the old style. A space former *A* was made to suit the width of the space in the clips. The parts *B* are adjustable jaws which are moved by the screw *C*. These jaws are held in place by springs fastened to hooks *D*. These springs are used for the purpose of keeping the jaws in position after adjustment, and to cause them to release the work after bending has taken place. The block *E* is given an inward movement by two cams or punches with angular ends set in the punch-head which, in turn, is attached to the press ram. As this ram moves downward, these cams come against the angular surfaces *H* and give the block *E* a forward movement toward *A* so that any stock placed between the parts *B* and *A* will be formed in a U-shape. Block *E* is returned to its original position by springs which are fastened to the pins *G* and the eye-bolts *I*.

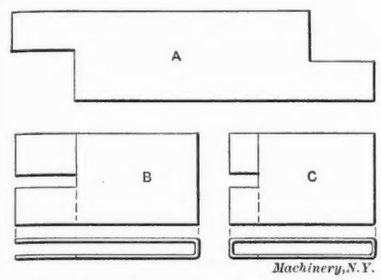


Fig. 1. The Blanked Clip and its Shape after the Two Bending Operations

The clip is now ready for the second and last bending operation, which is done in the tool shown in Fig. 3. This tool, as is the one shown in Fig. 2, is adjustable for anything within its range and forms 37 different clips; but 57 could be formed with it just as well. The tool is made entirely of steel and consists primarily of a base *A*, two blocks *B* which are adjusted by right- and left-hand screw *D*, two horizontal forming tools *E*, and a support *F* which is adjustable for clips of different heights. This adjustment was required in order to bring the space former (Fig. 4) upon which the clip is mounted during the bending operation at the right distance from the forming tools *E*. On this support *F* there is a small screw *C* which locates the former, thus bringing the work central. The punch *G* has two cams *H* and two formers *I*. These cams and formers are adjustable by the right- and left-hand screw *J*. To perform the last operation on the U-shaped piece, it is put on the space former (Fig. 4) which is then placed on top of the support *F* with the notched corner shown resting against the small screw *C*.

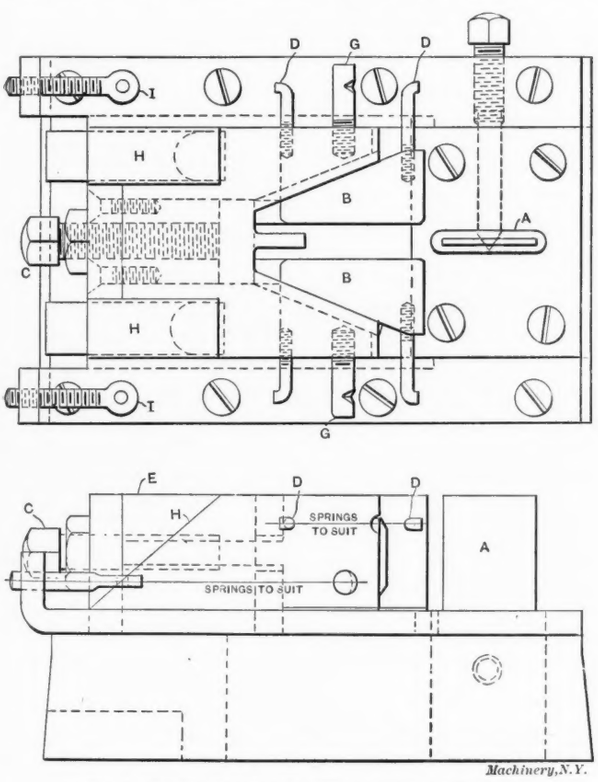


Fig. 2. Die for Forming the Clip as shown at B, Fig. 1

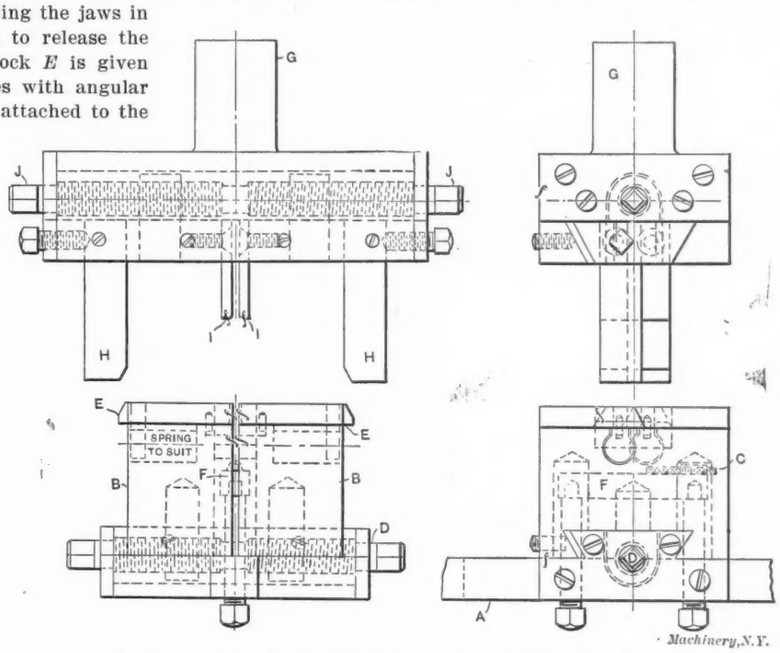


Fig. 3. Punch and Die for Finishing the Clip as shown at C in Fig. 1

The formers *I* are then adjusted to the outside width of the clip. As the formers *H* are fastened to the same block they are, of course, adjusted at the same time. As the press ram descends, the cams *H* strike the formers *E* and cause them to move toward the center of the die. This movement bends the prongs of the clip to a horizontal position; as the ram continues its downward stroke the vertical formers *I* bend these prongs down and set them. This finishes the second and last operation forming the piece as shown at *C* in Fig. 1. These tools have been in daily use since they were first made.

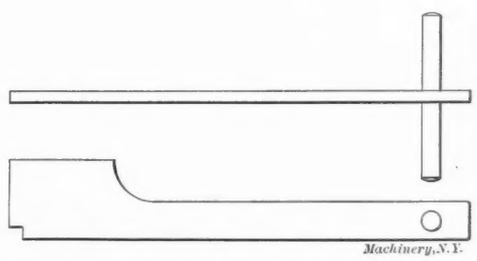


Fig. 4. Former upon which the Clip is Mounted during the Last Bending Operation

J. A. G. GOULET.

Peterboro, Ont., Canada.

* * *

A kink which comes from Carr Brothers, of Syracuse, relates to the cutting off of thin tubing of copper, brass, etc., with the power hack-saw. This is usually a matter of some difficulty, owing to the tendency of the saw to dig into the thin walls of the soft metal. To overcome this tendency, an old saw blade is used for this work. The blade is first run over the face of the emery wheel, so as to grind the teeth almost down to the roots, leaving only very small notches. The saw thus treated is used in the regular way. It cuts very slowly when it first begins, but works at good speed and without digging in during the remainder of the operation.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

FIGURING GEARING FOR WORM-WHEEL HOBBING MACHINE

J. B.—The engraving, Fig. 1, shows the gearing on a hobbing machine. Please explain to me how to figure and prove the change gears to cut a worm gear of, say, 50 teeth. A 48-tooth gear is sometimes used in place of the 96-tooth gear at *A*, when cutting a large number of teeth. Please explain how to allow for this.

A.—The way in which the machine is geared will depend on the assortment of change gears with which it is provided. If there is a sufficient variety of these, simple gearing may be employed, using an idler on the swinging arm to connect the gear on shaft *D* with gear *A*.

First find the revolutions of the hob for each revolution of the worm-wheel. This is found by dividing the number of teeth in the wheel by the number of threads in the hob, or worm, with which it is to run. For instance, if there are fifty teeth in the wheel and the worm is single threaded, the number of revolutions of the work to one of the hob will be $50 \div 1 = 50$. This may be called the *ratio* of the wheel. If the worm is double threaded, the ratio will be $50 \div 2 = 25$, and so on. With the gear connections you have shown for simple gearing, when *A* has 96 teeth, the gear on shaft *D* must have a number of teeth equal to 4 times the ratio; that is to say, if we have a worm-wheel with 50 teeth, driven by a

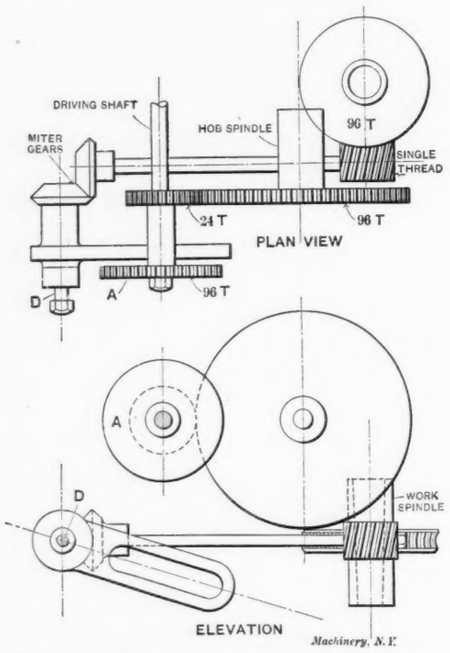


Fig. 1. Arrangement of Gearing in Hobbing Machine

double threaded worm, the ratio is 25, and the number of teeth in the gear at $D = 4 \times 25 = 100$. If a 48-tooth gear is used at *A* in place of the 96-tooth gear, the gear on *D* is found by multiplying the ratio by 2. If, for instance, the number of teeth in the wheel to be cut is 135, to mesh with a triple threaded worm, the ratio will be $135 \div 3 = 45$ and the number of teeth for gear *D* will be $2 \times 45 = 90$, when *A* has 48 teeth.

A wider range of ratios can be provided for with a given number of change gears if *A* and *D* are connected by compound gearing, as shown in Fig. 2, where *A* and *C* are the driving gears and *B* and *D* the driven gears. The rule for finding the number of teeth for *B*, *C* and *D* when *A* has 96 teeth then becomes

$$\frac{\text{number of teeth in } B \times \text{number of teeth in } D}{\text{number of teeth in } C} = 4 \times \text{ratio.}$$

When *A* equals 48, this becomes

$$\frac{\text{number of teeth in } B \times \text{number of teeth in } D}{\text{number of teeth in } C} = 2 \times \text{ratio.}$$

Suppose, for instance, that we have a set of change gears going by 6's, that is to say, the numbers run 18, 24, 30, 36, 42, etc., from 18 to 120. Suppose the ratio of the worm gear to be cut is 50, and the number of teeth in gear *A* is 96; then we have:

$$\frac{\text{number of teeth in gear } B \times \text{number of teeth in gear } D}{\text{number of teeth in gear } C} =$$

$$4 \times 50 = 200.$$

By selecting the 60-tooth gear for *B*, a 120-tooth gear for *D*, and a 36-tooth gear for *C*, we have

$$\frac{60 \times 120}{36} = 4 \times 50.$$

Proving the calculations of the gearing for this machine is practically the same, whether simple or compound gearing is

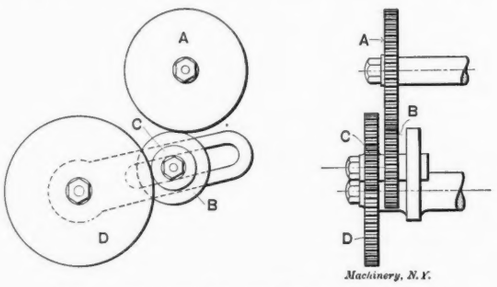


Fig. 2. Compound Gearing for Machine in Fig. 1

used. Consider that the whole mechanism is driven from the hob spindle; then the product of all the driven gears, divided by the product of all the driving gears, equals the number of teeth in the worm-wheel divided by the number of threads in the worm or hob. An idler gear between a driving and driven gear is not considered at all, as it has no effect on the motion other than to reverse it. Proving the first example by this method, we have

$$\frac{96}{1} \times \frac{1}{1} \times \frac{100}{96} \times \frac{24}{96} = \frac{50}{2} = 25.$$

The number of teeth in these driving and driven gears are given in their order from the work, through the mechanism, to the hob. The fraction $\frac{1}{1}$ represents the miter gears, which are of even ratio, but the number of whose teeth are not given. For the last example the proof is similar. Here we have

$$\frac{96}{1} \times \frac{1}{1} \times \frac{120}{36} \times \frac{60}{96} \times \frac{24}{96} = \frac{50}{1} = 50.$$

You can get further help in the matter of calculating gear ratios by studying Chapters IV and V of Shop Arithmetic for the Machinist, No. 18 of MACHINERY'S Reference Series

* * *

The purchasing agent of a large electric railway company until lately bought metal for car journal bearings of a certain concern, paying twenty cents a pound. The metal gave satisfaction, but the price was considered too high. A sample was sent to a chemist for analysis and upon receipt of the report, the purchasing agent sent out for bids on a metal of the composition shown by the analysis. A reliable concern at once offered the same metal at six cents per pound. As the amount of metal used in the year is large the saving is considerable. This is an example of the materials that can be bought on specifications to advantage. The purchasing agent, armed with the knowledge of the desired materials' constituents, sends out the specifications and asks for bids. Those who bid, do so with a knowledge of the characteristics of the required materials, and that the material supplied will be rejected if it does not come up to the specifications. The plan has been followed for many years by the Pennsylvania Railroad Company with great satisfaction.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

BLISS COMPOUND PNEUMATIC FORGING HAMMER

As may be surmised from an examination of the accompanying engravings, the pneumatic forging hammer shown herewith, built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., closely resembles the construction of the ordinary steam hammer used for the same work. At first thought it seems improbable that the interposition of an air compressor be-

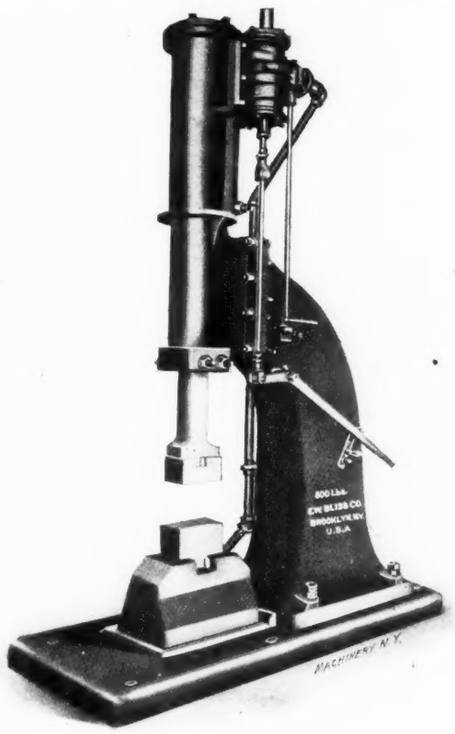


Fig. 1. An 800-pound Forging Hammer with Compound Cylinder, operated Pneumatically

tween the boiler and the hammer would result in any actual saving in time, expense and labor. A study of the design and use of the tool, however, as given in the following paragraphs, will show that there is warrant for expecting a saving from this construction.

Compound Air Distribution and Valve Mechanism

A most important improvement made possible by the use of air is the compounding of the cylinder so that the air is used expansively. Compounding has been tried many times with steam hammers, but has hitherto proved impracticable, on account of the tremendous condensation met with. By the time the hammer was ready to use the steam over again on the expansion stroke, there would be nothing left but water. With air, where there is no possibility of condensation, a high economy may be obtained by using the direct pressure for lifting the ram, and a second or expansion stroke for accelerating its downward movement. The arrangement of the cylinders and the valve mechanism for effecting this will be understood from a study of Figs. 2 and 3.

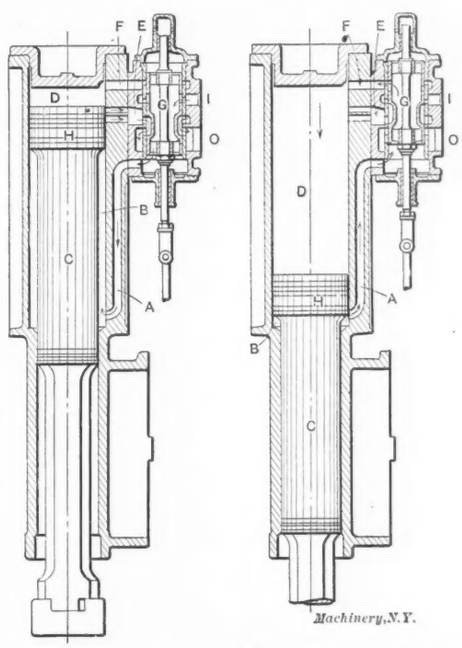
In Fig. 2 the hammer is shown raised to the upper limit of its stroke. The inlet is at *I*. From here the air follows the arrows through the port into the center of the valve *G*, and thence down through the lower port *A* into annular space *B*, and around the small diameter *C* of the piston, where it acts on the under side of head *H* to raise the ram. In raising the ram, the air in space *D* above the piston has been exhausted through ports *E*, following the arrows shown to exhaust *O*. Port *F* is closed by valve *G* in this position so that the upward movement of the piston and ram is limited by the cushion in space *D*.

On the down stroke the valve *G* is raised to the position shown in Fig. 3. Here the inlet *O* has been cut off, the interior of valve *G* being connected with port *F* instead, which thus puts space *D* in communication with annular space *B* below head *H* of the piston. (Owing to the fact that the air in *D* in Fig. 2 is under compression, the evil effect of the clearance at this point is not so important as would otherwise be the case.) Port *E* is closed so there is no escape to the atmosphere, and the air at initial pressure in *B*, *A* and *G* is thus allowed to expand in the cylinder *D*, accelerating the downward movement of the ram and increasing the force of the blow without requiring any perceptible increase in air consumption. On lowering the valve again, to the position shown in Fig. 2, the space *D* is again connected with exhaust *O*, and space *B* with inlet *I*, raising the piston again to the position shown in the illustration.

Provision for Using Direct Pressure on Ram

By examining the side of the hammer frame in Fig. 1, it will be seen that the downward movement of the valve lever (and the consequent raising of the valve) is limited by a pin. This pin may be removed, increasing the valve travel. This increased valve travel allows space *D* to be directly connected with the compressed air supply on the downward stroke, space *B* meanwhile exhausting into the atmosphere. This provision permits the striking of a much heavier blow than is indicated by the normal rating of the hammer, thus increasing its capacity for exceptional work. This increase of capacity is naturally obtained at the expense of economical working, so it is not recommended for regular practice. It has the advantage, however, of giving the tool an exceptionally high "over-load" capacity.

The action of the valve when raised to the direct pressure position will be readily understood from Fig. 4, where it will



Figs. 2 and 3. Position of Valves and Flow of Air in Compound Cylinder, with Ram held up and down, respectively

be seen that the air at *B* escapes into *D* as before, but that in addition the inlet supply at *I* is connected by means of the annular passage around valve *G* with ports *E*, leading to space *D* above the piston.

Fig. 5, which has reference letters corresponding to Figs. 2, 3 and 4, shows the arrangement of the valve mechanism for the largest size of double frame hammers, such as shown in Fig. 6. The reference letters correspond in all the engravings, and the principles of operation are the same for both cases.

Incidental Advantages of the Use of Air

Besides the advantage of using the air expansively as just described, there are a number of other advantages attaching to the use of air in place of steam. Long steam lines and a high rate of condensation are almost inevitable with the steam hammer. It is common practice to leave the drip

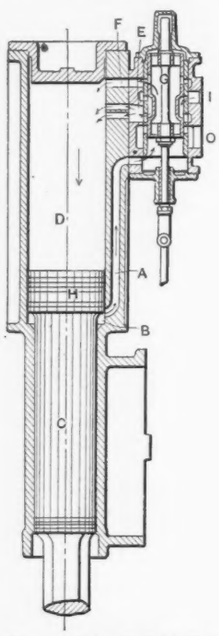


Fig. 4. Using Full Air Pressure on Down Stroke

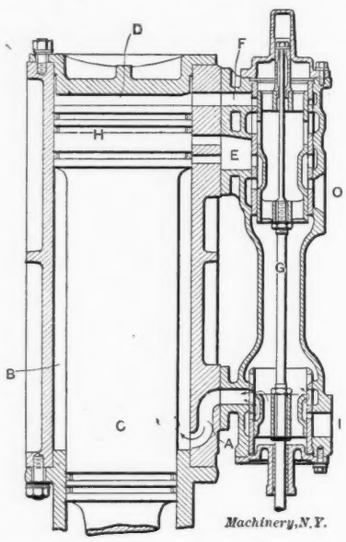


Fig. 5. Valve Arrangement used on the Large Sizes

valves open for the line, the cylinder and the exhaust, this being necessary to take care of the amount of water produced. The escape of steam through these openings amounts to more than a small percentage of the amount of steam usually employed. In this hammer no drips are necessary, as the air is relieved of its water in the receiver. Furthermore, long lines are unnecessary, as the compressor may be placed in the closest and most convenient position with relation to the boilers, irrespective of the position of the hammer and the furnace. It is also feasible to use a compressor of high commercial efficiency, using the steam in a far more efficient manner than in the crude mechanism of the ordinary steam hammer. The saving from these sources is considerable.

The heavy condensation in the cylinders when using steam results in a constant flow of water through the stuffing boxes, down the piston, and onto the die faces. This makes it necessary to exercise great caution in striking the first blow on a piece of work, as striking the red hot forging loosens the scale. This makes a heavy blow dangerous, as the flying scale and metal are liable to injure the workman. For this reason the first blow given by the hammer man to a new spot on a forging is habitually light, so as to either compress the scale or knock it off. This blow is wasted so far as effectiveness in shaping the work is concerned, though it uses about as much steam as a heavier stroke. The absence of drip in the pneumatic hammer overcomes these difficulties, and the corresponding freedom from loose scale permits keeping the die faces clean, thus giving them much greater durability. The fact that there is but one line of piping, that for the air pressure, simplifies the matter of installation and maintenance. The exhaust takes place directly into the atmosphere, thus assisting in cooling and ventilating the building instead of heating and vitiating the atmosphere as in the case of a steam hammer.

Details of Mechanical Construction

While the hammer is made in the single frame design, shown for the 800-pound hammer in Fig. 1, for the larger sizes the double frame type shown in Fig. 6 is used. As will be seen in Figs. 2 to 5, these tools are of simple construction, with very few wearing surfaces. The small part of the cylinder forms a guide for the ram, which with the jaws for the die, are forged from a solid steel ingot. The shape of the section of the ram is nearly uniform throughout, while the cylindrical portion is almost entirely contained in the guiding cylinder when the blow is struck. Ordinary piston rings are employed in the guiding cylinder as well as on the main piston head, making the use of stuffing boxes unnecessary. The freedom from friction thus obtained is an important factor in increasing the efficiency of the machine.

The use of air in place of steam simplifies the mechanism in a number of ways. The absence of condensation, just mentioned, makes it possible to strike the first heavy blow without working the hammer. For this reason the automatic striking attachment usually found has been dispensed with. The valve is thus controlled by one hand-lever and the hammer is more simply operated. Proper manipulation of the single handle will give any weight of blow, light, heavy, exceeding heavy or holding down, as required. When the handle is raised, the ram rises and remains in its highest position.

The piston and dies are kept from rotating by wooden jaws, which bear against the flattened sides of the ram between the die head and the smaller diameter of the piston. These are kept automatically lubricated and have no other function than that of keeping the piston from twisting, so the service on them is not severe. A detail of interest will be noted in Figs. 2, 3 and 4, where it will be seen that the bearing surface by which the cylinder casting is bolted to the frame

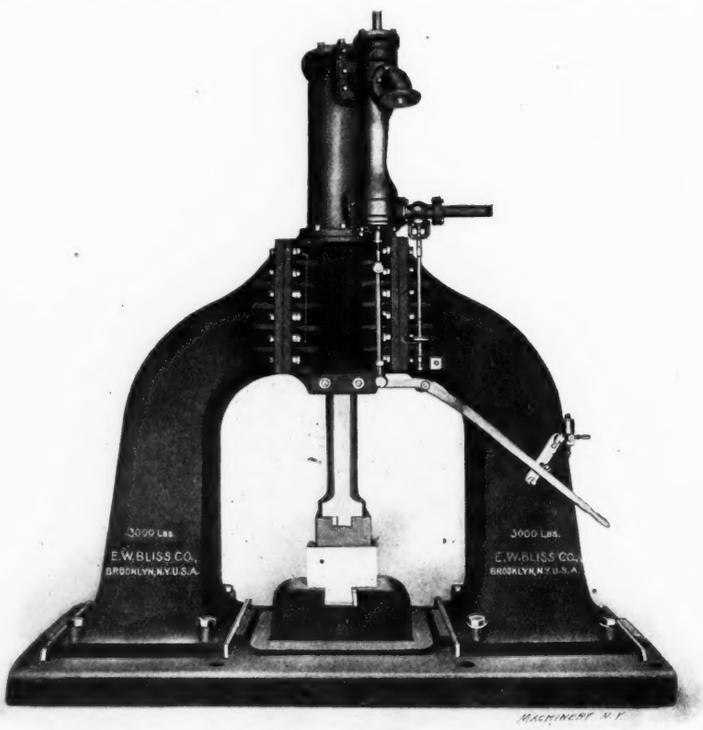


Fig. 6. Heavy Double-frame Pneumatic Forging Hammer

is provided with a tongue, engaging a corresponding groove in the frame. This takes the thrust and jar, relieving the bolts from shearing strain. The latter may, in fact, be quite loose without harm to the mechanism.

Sizes and Capacities

This pneumatic forging hammer is made in ten sizes, ranging from 150 pounds to 6,000 pounds. These figures give the

nominal size of the hammer, reckoned on the basis of the actual falling weight in pounds. The maximum blows per minute range from 120 for the smallest size to 30 for the largest size. These hammers are designed to use air at the usual shop practice of 80 pounds per square inch. Their consumption of free air in cubic feet per blow at this pressure ranges from 0.158 to 11.2 cubic feet per blow. The capacity of compressor recommended ranges correspondingly from 30 to 450 cubic feet of free air per minute.

An interesting application of the two smaller sized hammers (150 and 250 pounds) has been found, which is made possible by their operation with compressed air. This relates to the hammer for forging and dressing tools, such as are used in mines, quarries, etc. Such establishments are usually already provided with the necessary air pressure, so that the matter of providing a hammer is very simple as compared with installing one of the old style. These light hammers are mounted on trucks and may be moved from place to place whenever their service may be required.

Summary of Advantages

In brief, the advantages claimed for the use of air in this forging hammer are as follows: Greater economy through the use of the compound principle; increased capacity from the provision of direct action for taking heavy blows; no condensation and consequent economy in the use of steam—both in that escaping in the drip and that used when working out the hammer to free the cylinder of condensation; no long steam lines; location of compressor close to boiler and possibility of using a light economical form of engine and compressing mechanism, in place of the inefficient mechanism of the steam hammer; simplicity of construction and operation.

This tool is of English origin. The makers have had one of the smallest sizes, such as shown in Fig. 1, in use in their shops for many months, and their favorable experience with it has led to their purchase of the American rights for these tools. The 3,000 pound hammer shown in Fig. 6 was supplied to the Lackawanna Railroad Co., for general railway forging. In this work it has given complete satisfaction.

DAVIS CLUTCH

The clutch illustrated in the accompanying engravings is made by the Davis Clutch Co., 1232 East 3rd St., Cleveland, Ohio. It is the result of a desire of the makers to obtain a simple, durable and efficient construction embodying all the requirements necessary for meeting the exacting conditions under which such mechanisms are used.

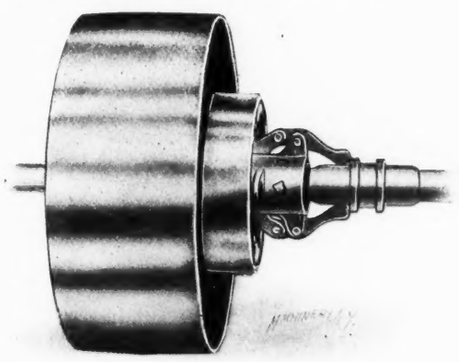


Fig. 1. The Davis Friction Clutch

The construction of this clutch is plainly shown in Figs. 2 and 3. The body piece *A* is keyed to the shaft. On this are hinged at *B* two friction rings *C*, which extend all the way around the hub and are pressed by the levers shown against the inner flange of the friction rings or hub *D*. On this latter member is mounted the pulley or gear which it is desired to connect with or disconnect from the shaft.

A compound lever system is used. The thimble *E* in Fig. 2 spreads apart the outer end of levers *F*, and thus tips up the toe of lever *G*, which is fulcrumed on the hub of the body piece against adjusting screw *J* in the friction rings. As shown, these rings terminate at one end in two lips provided with through-bolt *H* and springs, which assures plenty of clearance when the levers are dropped and the clutch is thrown out. A variation in the lever mechanism for larger clutches is shown in the lower view of Fig. 2. Here levers *F'* are connected with sliding sleeve *E'* by means of links as shown, the rest of the mechanism being practically identical with that just described.

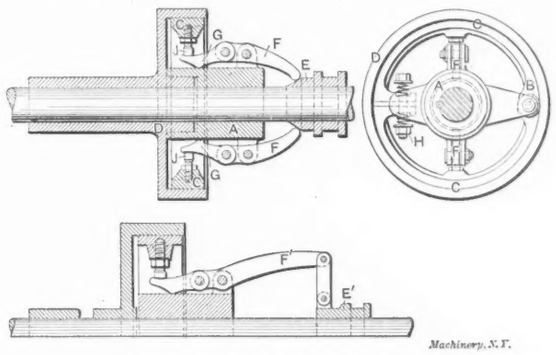


Fig. 2. Construction of the Davis Clutch

The provision for adjustment is very simple, and practically unlimited in range. The adjustment of the clutch is effected by throwing it into engagement, and then tightening down set-screws *J* with the same force on each side, to the degree desired, locking them at that point with the jamb nuts. Equal bearing of the fingers and levers on both sides of the thimble *E* holds the latter rigidly in place, and prevents spring of the shaft. The clutch is carefully balanced, so that there is no vibration, with consequent danger of jarring the thimble out of position.

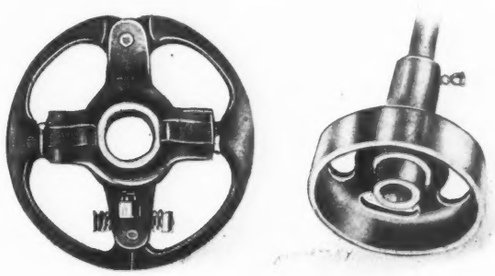


Fig. 3. The Clutch Disassembled

The matter of lubrication has been carefully attended to. Sleeve *D*, it will be seen, is of great length, being extended forward into a counterbore recessed into body piece *A*. From an oil chamber in the center of the sleeve (not shown) oil is distributed over the bearing through carefully located channels. It is recommended that the friction surfaces be lubricated with cup grease or vaseline; this improves their durability and action.

This clutch is very compact, and is easily adapted to special uses in machinery of all sorts. The length of the hub and diameter on *D* may be varied to suit the machine where it is to be used, and special forms may be given to this member to meet unusual requirements.

A test of a series of these clutches was recently made by an impartial investigator, Professor R. H. Fernald, of the Case School of Applied Science, Cleveland, Ohio. The purpose of this test was to enable the manufacturers to make conservative guarantees of the capacity of their productions when installed in the shops of their customers. They were made under the following conditions:

(1) The clutch must run perfectly free when no load is applied. (2) The load carried during each test must be entirely removed before releasing the clutch, and upon releasing, the clutch must run free, and the shaft must come speedily to rest. (3) With the clutch set as indicated in (1) and (2) the following ratings must be determined: (a) The load which the clutch, when suddenly thrown into action, will readily pick up and carry for a period of 15 minutes. (b)

The maximum load which the clutch will carry when the load is gradually applied. This maximum load is also to be carried for 15 minutes.

The five clutches submitted for test were tried out on the above basis. The principal dimensions and the results secured are presented below.

TABLE I.

Clutch Number	Diameter of Friction Surface, Inches	Outside Diameter of Clutch, Inches	Width of Friction Surface, Inches
6	5 5/16	6 1/8	1 5/16
8	7 5/16	8 1/4	1 3/4
10	9 7/16	10 1/16	2 1/4
14	13 1/4	14 1/4	2 3/4
18	16 3/4	18	4

Under the conditions specified above, the following results were secured:

TABLE II.

Clutch No	6	8	10	14	18
Max. "pick-up" load, pounds.	21.5	50.5	70.5	254.0	354.0
Revolutions per minute for maximum "pick-up" load..	91.4	111.7	122.8	119.3	133.8
Horse-power transmitted for maximum "pick-up" load at r. p. m. indicated.....	1.96	5.64	8.66	30.3	47.3
Maximum load carried.....	35.5	58.0	81.5	254.0	354.0
Revolutions per minute for maximum load carried	86.5	111.0	129.8	119.3	133.8
Horse-power transmitted for maximum load carried, at r. p. m. indicated	3.07	6.40	10.57	30.3	47.3

Rating the clutches on the basis of 100 revolutions per minute, the horse-power transmitted was as follows:

TABLE III.

Clutch No	6	8	10	14	18
Horse-power transmitted for maximum "pick-up" load...	2.15	5.05	7.05	25.4	35.4
Horse-power transmitted for maximum load carried	3.55	5.80	8.15	25.4	35.4

These clutches are made in sizes to deliver from 3 to 60 horse-power, at 100 revolutions per minute. Besides the difference in the lever mechanism shown in Fig. 2, the clutches are furnished in two styles, depending on whether they are to be used for counter-shaft or main line use. In the former case two levers are used, each friction ring having a single bearing point on the lever, as here illustrated. For line shaft use, four sets of levers are used, each ring having two bearings.

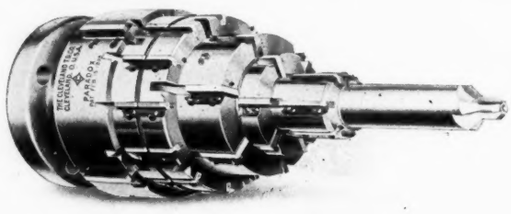
The tests given above are worthy of record as giving authentic results for commercial clutches under laboratory conditions.

CLEVELAND MULTIPLE REAMING AND FACING TOOL

The accompanying engraving shows a remarkable inserted tooth multiple reamer, recently built by the Cleveland Twist Drill Co., of Cleveland, O. It was built for a well-known cream separator company, and was designed for rough reaming and facing eight diameters, completely finishing all the holes in the casting on which it is to be used.

The body is made of a cylindrical casting carrying the outer blades, into which is fitted a second and smaller body of machine steel, turned and slotted to receive the next three sets. This body in turn holds the counter-sink, which is made of hardened tool steel. The tool is 21 inches long, and 6½ inches in diameter, weighing nearly 100 pounds. The counter-sink, five reamers and the formed facing tool for facing and rounding the top ring, require in all 34 inserted blades. Twelve of these are of the double combination cutting type, making, with the four counter-sink lips, a total of 50 cutting edges. The tool, in use, is bolted on the boring head of a large horizontal boring machine.

The prime advantage of this construction is that the cost of the whole tool is considerably less than that of the set of individual ones necessary to perform the various operations. Another obvious advantage results from performing a number of operations at one time, thus saving labor and time. The high speed steel blades used reduce the necessary regrinding to a very small amount. The adjustable blade feature in this, as in other similar designs, is an important



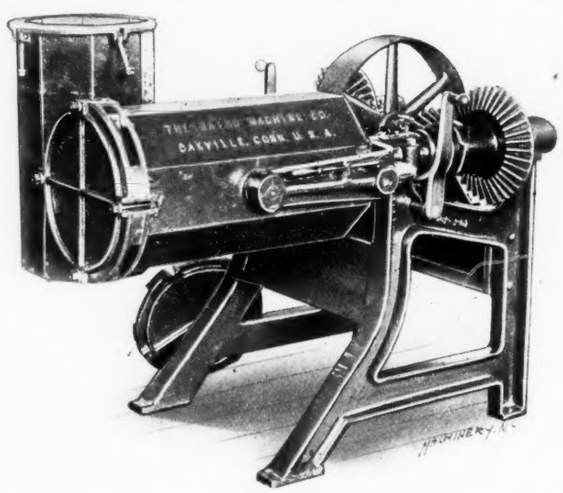
A Multiple Reaming and Facing Tool with Thirty-four Inserted Blades and Fifty Cutting Edges

feature in the economy of the device. A solid, built-up reamer of the same character would scarcely pay in service for the large initial expense, since when one of the reamers is worn below size, the usefulness of the tool is destroyed. These blades, on the other hand, can be adjusted whenever required, and may be replaced with new blades at small cost when worn out.

BAIRD DOUBLE HORIZONTAL TILTED TUMBLING BARRELS

The tumbling barrel shown herewith is designed especially for rolling small metal articles with steel balls. This operation may be employed for burnishing such work before plating, or polishing it afterwards. It has been largely used on such articles as electrical fittings, typewriter, adding machine, and similar parts, chains, collar buttons and other jewelry, fancy hardware, etc.

The machine is double, as may be seen. The barrels are of cast iron, lined with maple. This lining is very durable, and when worn out, may be easily replaced, thus preserving the



Tumbling Barrels of Convenient Construction, especially adapted to Polishing Work with Steel Balls

iron barrel indefinitely. The barrels are carried on forks on the ends of the spindles, being pivoted near their centers. A slight push on the locking pin allows the barrel to be swung from the horizontal operating position to the upright position for inspection, or to be dropped to the reverse position for dumping. The cover bolts may be quickly loosened and thrown back, permitting the cover to be removed. The operation of emptying out the work is thus one of moments only.

The advantages of this construction are obvious. There are no loose parts, the cover bolts being hinged to the barrel itself, and the nuts have only to be loosened and not taken off, so there are no parts to be lost. Each barrel is independently driven by a clutch engaging the driving gearing, so

that one of them can be emptying and refilling while the other is in motion. The barrels are water-tight, each being provided with a rubber gasket.

This machine is made in but one size, having a barrel 10½ inches inside diameter by 24 inches long, geared 2 to 1, with a driving pulley intended to run at about 60 revolutions per minute. This machine has a net weight of 1,300 pounds. Two other sizes will be made to order, or any other requirements on the part of the customer will be specially looked out for.

RIBLET TRANSVERSE CURRENT WATER HEATER

The apparatus shown herewith is called by its builder (the Riblet Heater Co., of Erie, Pa.) the "transverse current water heater." It may be used as an ordinary feed water heater, using the exhaust of a steam engine, but it has been especially adapted to the heating of water for shop, laundry, hotel or other purposes from the exhaust of the gas engine. It is believed to be the first commercially successful device for this latter purpose that has been placed on the market. As is well known, only a comparatively small percentage of the heat of the gas used in generating power in the gas engine, is changed into work. The balance is wasted through the exhaust and the water jacket. The exhaust has a temperature of from 600 to 1,000 degrees, and this heater is designed to save all of this heat that can possibly be saved. It has been found that with an engine using 15 cubic feet of gas per hour, nearly two-thirds of the total heat is thus made available. It has been calculated and found from experience that, allowing for loss from radiation, etc., one of these heaters will raise the temperature of nearly 70 gallons of water from 40 to 200 degrees per hour, for each horse-power developed by the engine.

In construction the heater, as may be seen in Figs. 1 and 2, consists of a series of flat rectangular passages, of sufficient number to give the required heating surface. These are so arranged in connection with the inlet and outlet openings at the end that the exhaust enters the heater at the bottom, passing through a sufficient number of these passages or ports to avoid back pressure, and then turns backward again, passing through from side to side of the heater from three to five times before reaching the exhaust outlet which is located at the top.

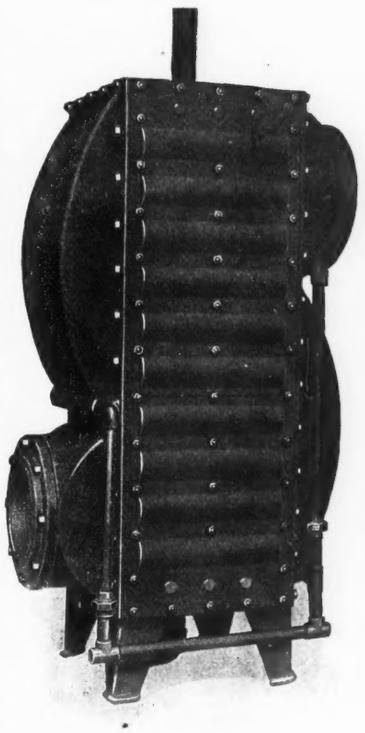


Fig. 1. Water Heater adapted for Use with Gas Engine Exhaust, as well as with Steam

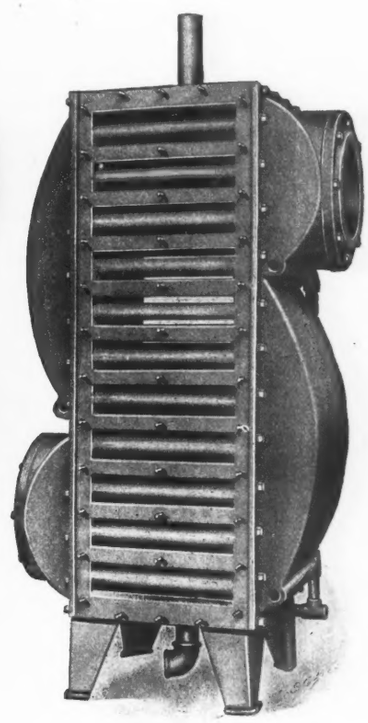


Fig. 2. Casings removed, showing Reverse Courses of Water and Exhaust

The water enters the heater at the top, passes over the first port, back over the second, over the third, back over the fourth, etc., from top to bottom. This back and forth movement is controlled by the circulation plates. The water thus goes through but one passage at a time, traveling downward across, and in the opposite direction to, the exhaust. In this way, the hottest water, just as it leaves the heater at the bottom, passes through the section heated by the hottest exhaust. When more convenient for installation this order can be reversed without interfering in any way with the circulation. The entire heating surface is thus made effective, and as the water is constantly agitated, the maximum amount of heat is absorbed.

As a feed water heater operated by exhaust steam, this device has the advantage of being made entirely of cast iron, which does not readily corrode, and is not readily affected by electrolysis or acids. As the result of this precaution the life of the heater is, of course, greatly prolonged. There are no tubes to collect scale, no internal joints to leak, and the water does not come in contact with the exhaust.

This heater has been thoroughly tested out for some months in connection with both steam and gas engines, the results in both classes of service being satisfactory to the makers and users.

"NU-CLINCH" BELT AND ROPE DRIVE SURFACERS

The Improved Surface Co., North Tonawanda, N. Y., has placed on the market a line of belt and rope dressings which are designated respectively as the "Nu-clinch cleaner," "Nu-clinch filler," "Nu-clinch preserver" and "Flexite surfacer." The first two are intended for general belt use, the preserver is used on old worn-out belts, while the flexite surfacer is intended as a dressing for rope drives.

These compounds are composed of lubricating liquids of great penetration, which enter into the pores of belt or rope, reducing their internal friction, at the same time that they prevent them from slipping on the pulley or sheave. The material spreads throughout the belt and does not gum up, keeping the surface open and unglazed.

These products are given a careful chemical inspection before leaving the factory, together with the mechanical tests necessary to insure that they will produce the results for which they are sold. Each lot is thus tested. Samples will be sent free on request. They are put up for sale in 14- and 35-pound packages and barrel lots.

PEERLESS V-BELT

We describe and illustrate herewith a belt made by the Peerless V-Belt Co., 215-219 So. Clinton St., Chicago, Ill., which possesses many advantages over both the chain and the leather belt. It is designed to give a maximum of capacity and durability in the same product. Its construction will

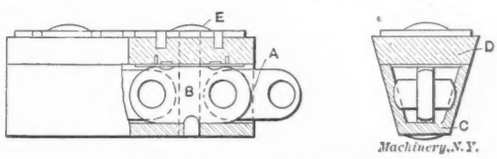


Fig. 1. Construction of the V-Belt

be understood from Fig. 1, where it will be seen to be composed of a central core of blocks *A* and side links *B* forming a steel chain, surrounded by a raw-hide and friction paper casing *C* and *D*. The cross-section of the belt is of V shape, to fit the grooves in the pulleys over which it runs.

The lower or raw-hide casing *C* is a continuous strip, covering the bottom and the two sides of the chain. This material gives a friction surface of great efficiency, the coefficient of friction of raw-hide on cast iron being very high. The upper part of the casing is of friction paper, there being one section to each link of the chain. It is pivoted at an angle so as to continue the friction surface up the sides. Each section is fastened to the link by a rivet *E* passing through it.

The pulleys used are provided with grooved faces, cut to an included angle of 28 degrees, which has been found the most suitable for this work. At this angle the friction is very efficient, and still the chain does not become wedged into the grooves so that power is lost in pulling it out after it has gone round the pulley. To preserve the wedge-like tightening of the chain in the groove, the bottom of the later must be deep enough so that the belt will not touch it under any conditions, thus destroying the wedging effect and reducing the friction. It is not necessary in installing this belt chain to purchase new grooved pulleys in place of the old straight faced ones. Special V-groove rims will be furnished by the makers, so constructed that they may be placed on any ordinary flat faced pulley.

It was stated that capacity and durability were two prime points of the excellence aimed at in the construction of this belt. As to capacity, it is stated that raw-hide has a higher coefficient of friction than leather. The weight of the belt, where the center distance is reasonably large, causes the chain to wedge firmly into the groove, giving it a high transmitting capacity. The raw-hide itself is not subject to tension, only to the compression and transmitting strain. Under these conditions it is very lasting and may be subject to continued dampness without being impaired by it. Durability is also obtained by the careful fitting and hardening of the chain. The sides of the link and the forged connecting blocks are pack hardened to as high a degree as practicable. The rivet passing between the side links keeps these far enough apart to allow the free action of the block when the chain is bent around the pulley.

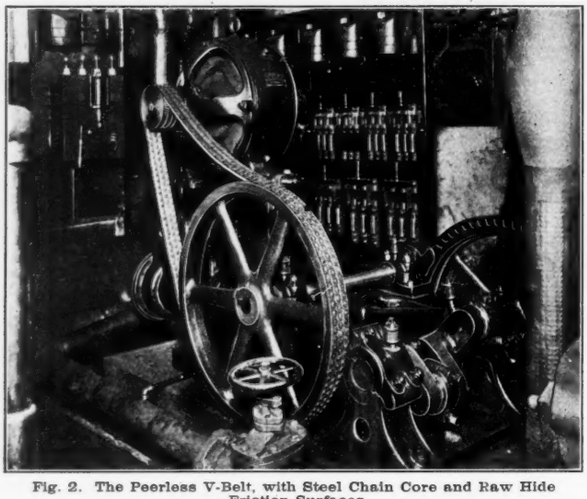


Fig. 2. The Peerless V-Belt, with Steel Chain Core and Raw Hide Friction Surfaces

The high efficiency obtained by the wedging action in the grooves of the pulley should give, from theoretical considerations, fully four times the capacity of a flat leather belt for the same width. This has been verified in practice. The following comparisons are based on the safe assumption that a flat belt 1 inch wide requires about 800 feet per minute of contact for each horse-power transmitted. The V-belt is made in two sizes, one ⅞ inch across the top and the other 1¼ inch. The ⅞-inch size will transmit 1 H. P. for every 200 feet per minute of contact. The larger belt requires only about 130 feet per minute per horse-power. This holds true even for short center distances, scarcely longer than those used for chains. For extremely short center distances, slightly larger velocities are required per horse-power.

The advantage of this belt over the ordinary flat belt lies in its strength and carrying capacity. As compared with the chain drive it has the advantage of being perfectly noiseless. It can also be used at much higher speeds. On small pulleys it may be used easily up to 3,000 feet per minute, while on pulleys of ample size it may travel at speeds as high as 5,000 feet per minute. When once put on, it requires very little attention. An occasional lubrication of the chain three or four times per year is all that is necessary. Any ordinary mineral lubricant is used, a drop or two being poured between each block as it passes over the sheave. The raw-hide absorbs a good deal of this and as it is in constant contact with the joints of the chain, it serves as a reservoir, supplying the lubricant for a long time.

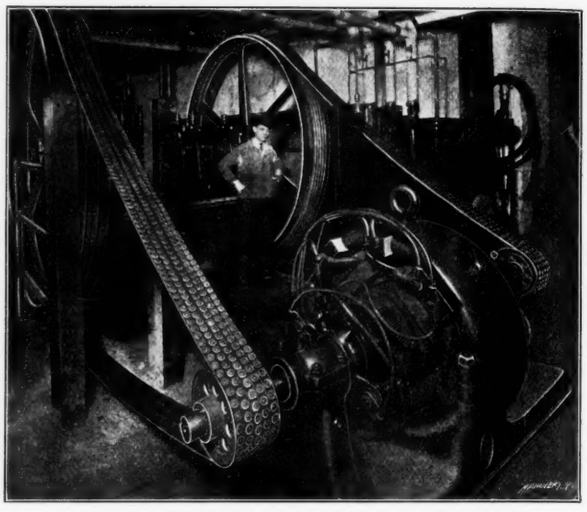


Fig. 3. Driving a Pump for High-pressure Electric Service

Two interesting applications of this belt are shown in the accompanying half-tone engravings. In Fig. 2 a 15 H. P. motor is direct connected to a duplex pump at a center distance of 36 inches. The pump was formerly used with a gear drive, which caused annoyance to the tenants from noise and vibration. The V-belt installation has worked noiselessly and furnished ample power. Fig. 3 shows a 50 H. P. motor driving an elevator pump, working at 900 pounds pressure. The ratio of pulley diameters is about 1 to 10. Formerly two 12-inch flat belts were used, pressed down by idlers weighted to 230 pounds each. An auxiliary pump was required to keep up the pressure during rush hours. With the V-belt and without idlers, slippage has been eliminated and the one pump does the work. A saving of 6 per cent on the power used has been effected.

IMPROVEMENTS IN THE TILTED TURRET SCREW MACHINE

In the department of New Machinery and Tools of the August, 1907, issue of MACHINERY, we described the original

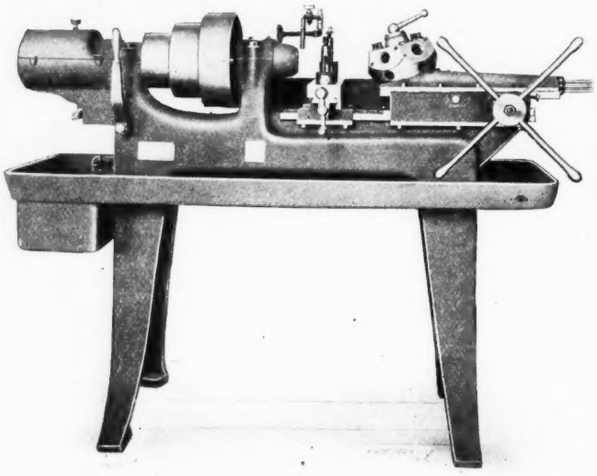


Fig. 1. New Design of the Tilted Turret Lathe

design of the tilted turret lathe built by the Wood Turret Machine Co., of Terre Haute, Ind. The construction which

gives this machine its name, as described at that time and as plainly shown in the accompanying view in Fig. 1, is the setting of the axis of the turret at a considerable angle from the vertical position. While this had previously been done on the heaviest class of such machinery, its application to a small turret lathe was new, and it was applied in such a way as to offer distinct advantages not previously obtained.

In the first place, the tilting of the turret obviously allows the use of tools of large diameter. It allows such tools to swing over the rear of the turret slide, while still permitting a low and rigid design of the turret. The angle to which the turret is tilted is 15 degrees, so that tools are swung up at an angle of 30 degrees from the horizontal in the rear position. An exclusive feature of this turret is the continuation of each hole through the stationary turret stud and out through the further side of the turret, below the tool hole on that side. It is thus possible to pass bars of stock of great length through the hollow tools, without requiring excessive overhang. The tilting of the turret also brings the pressure of the thrust directly on the slide, which is brought up almost on a line with the center of the spindle. This relieves the center post from strain, and increases the rigidity and cutting power of the tool.

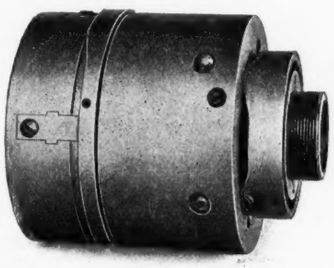


Fig. 2. Automatic Roller Feed Mechanism removed from the Machine, showing Compact Construction

The New Roller Feed Mechanism

The design of this machine shown in Fig. 1 has among its other improvements a continuous automatic bar feed in place of the old-style wire feed previously used. The compact and simple construction of this mechanism, shown in Figs. 2, 3 and 4, has made its use possible on this comparatively small machine. Fig. 2 shows the mechanism removed from the spindle. Fig. 3 shows a cross-section of the device in place on the machine, while Fig. 4 shows it disassembled, with the working parts in full view. When the lever *A*, see Fig. 3, is pushed to the left, wedge *B* is forced between two brake arms *C*. These arms are pivoted at *D* so that their upper ends are caused to close around scroll *E* and grip it firmly, stopping its revolution. As the spindle and casing of the mechanism continue to revolve, gears *F* and *F'*, meshing with scroll *E*, set in motion gears *G* and *G'* and rollers *H* and *H'* which roll the stock in or out according to the direction in which the spindle is revolving.

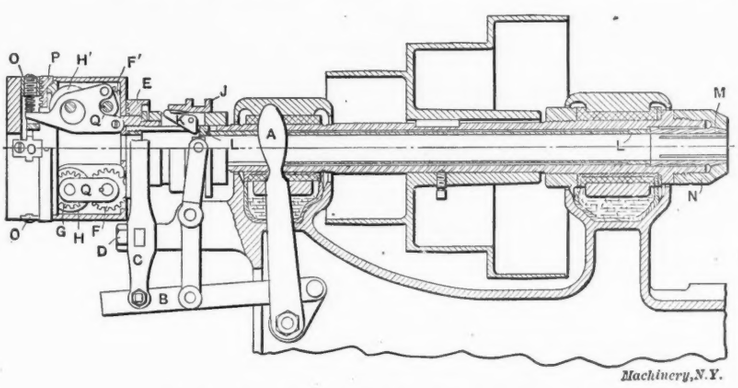


Fig. 3. Details of Chuck and Roller Feed Mechanism

As shown in Figs. 3 and 4, provision is made for adjusting the rolls to the diameter of the stock simultaneously with the adjustment of the supporting jaws at the rear end of the spindle. These latter, shown at *O*, are simultaneously adjusted in or out by means of a scroll *P*. Two of the jaws *O* are provided with slots and spring pressure devices for operating the pivoted jaws *Q* and *Q'* in which rollers *H* and *H'* are mounted. There is thus but one adjustment for changing the supporting jaws and rolls to suit different diameters of work. Suitable provision is also made for taking square, hexagon, and other shaped stock through this mechanism as well as round stock.

Lever *A*, besides operating the roller feed, opens and closes the split chuck at the front of the spindle, opening it before the feed is thrown into action when the lever is moved to the left, and closing it after the stopping of the feed when the lever is thrown to the right. The mechanism for doing this will be understood from Fig. 3. In throwing lever *A* to the right, clutch collar *J* acts on chuck fingers *K*, which in turn force tube *L* against collet *M*. The latter seats in the tapered nose of hood *N*, thus holding the collet down on stock. The control of the chuck and of the feeding by the same lever gives rapidity of action and at the same time eliminates the destructive wear which would occur when trying to roll stock into the machine while the collet is gripped down upon it.

Fig. 3 shows the self-oiling arrangement used on the spindle bearings in this machine. Each bearing, as shown, has a groove in it through which is laid a wick with its ends dipping into the reservoir below. The thrust bearing, as shown, is at the front end of the spindle.

Construction of the Turret, Turret Slide and Saddle

Fig. 5 shows a detail view of the turret slide mechanism, illustrating the tilted turret construction very plainly. As explained, this permits the use of large box tools and die heads, while the double set of holes and the stationary stud allow the passage of long work clear through the turret, even with all the faces occupied. The turret being hexagonal in form, permits tools to be bolted to the face, thus giving a more rigid support to the tool, and leaving the turret hole free for the passage of large work.

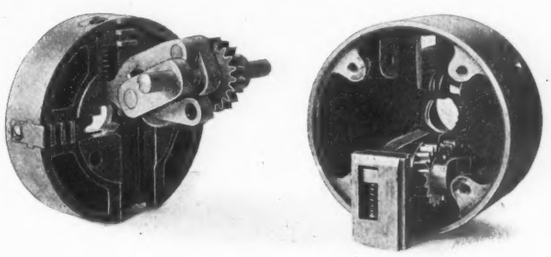


Fig. 4. Feed Mechanism Dismantled, showing Construction

The bearings of the cross-slide rest and of the turret slide and the saddle, are furnished with taper gibs passing the whole length on each side. This gives a crosswise adjustment to the turret. The saddle is held to the bed at the outer edges by flat gibs throughout its entire length. It is held down onto a supplementary taper base which is interposed between it and the top of the bed. By adjusting this taper base the center lines of the turret holes can be adjusted to the exact height of the center of the spindle.

The turret slide is shown removed from the saddle in Fig. 7. This, in conjunction with Fig. 6, gives a good idea of the arrangement of the indexing and stop mechanisms. At *A* is a latch pin which may be pulled out to cause the indexing finger *B* to clear the star wheel *C*. This simple provision sets the machine instantaneously for non-indexing work, as required by one-operation jobs made in large quantities. *D* is the locking pin which passes through the slide into the turret. The locking pin lever *E* is acted on by the eccentric cam *F* on the backward motion of the slide on the saddle. This pulls the bolt clear of its hole in the turret so that there is no dragging on the bottom bearing. The pin is held clear until the turret is revolved to the next hole, when it automatically drops into place and locks the turret.

In Fig. 5 is shown the turret and slide with the accompanying mechanism. Near the turret is seen the center bolt by means of which it is tightened down on the slide. The hole

through this bolt for the passage of the work is plainly seen. It will be noticed that this bolt is provided with a double taper bearing, seated in the turret. This may be adjusted to give the turret free movement at all times and still hold it firmly. With the backward movement of the slide the indexing finger *B* engages star *C* on the inner side. This through a geared connection shown more plainly in Fig. 7 swings the turret for one-sixth of a turn. The ratchet is fast to crown gear *C*, which engages a bevel gear screwed and doweled to the base of the turret.

As stated, a stop is provided for each hole in the turret, these stops being shifted automatically as the turret revolves.

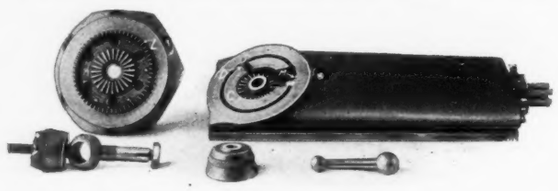


Fig. 5. Turret Slide removed from Turret, showing Construction of Stud Revolving Mechanism, etc.

They are contained in a drum as shown in Fig. 7, mounted on a long shaft connected by bevel gear *M*, see Fig. 5, through an intermediate, with bevel gear teeth *L* cut in the base of the turret. The automatic stops are adjustable for each tool without disturbing the others.

A self-oiling counter-shaft is furnished with each machine. The two friction pulleys in the counter-shaft are of single piece construction. Oil reservoirs are cored completely around the bearings, and the space is filled with cotton and oil. The hanger shaft bearings are supplied by oil boxes

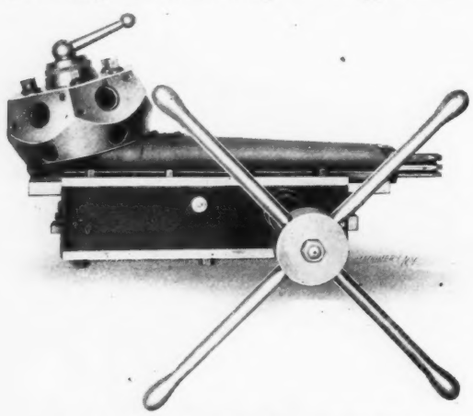


Fig. 6. The Turret, Turret Slide, and Saddle

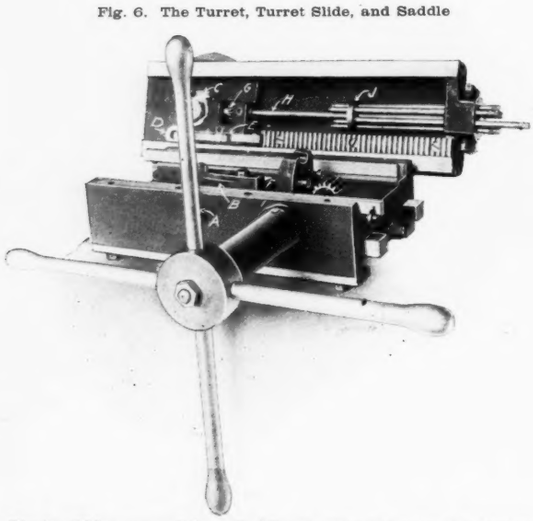


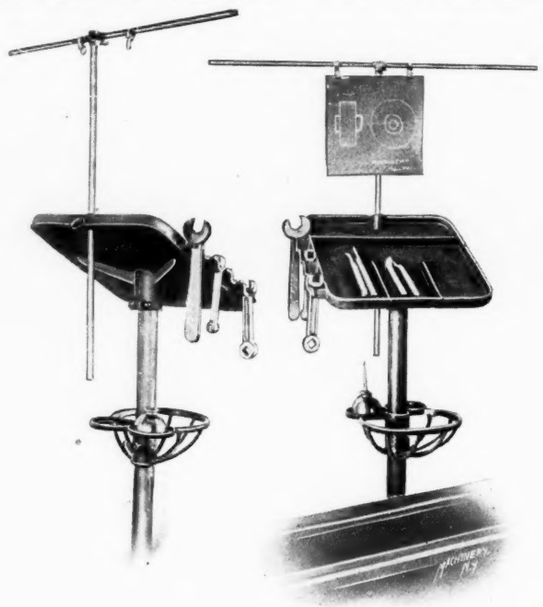
Fig. 7. Slide removed from Saddle, showing Indexing Mechanism and Adjustable Stops

below them. Each of them is oiled in a way similar to that shown for the spindle bearings in Fig. 3.

These machines may be seen in operation by a visit to one of the demonstration shops of Hill, Clarke & Co., Inc., of Boston and Chicago, or their branch offices at New York, Philadelphia, and Cleveland.

WELLS TOOL TRAY AND STAND FOR LATHES

The accompanying illustration shows a lathe tool stand or holder, made by F. E. Wells & Son Co., Greenfield, Mass.



A Convenient Tool Holder and Stand for the Lathe Operator

This device, which can be fastened to any lathe, is provided with places for oil cans, a basket for waste, a tray for lathe tools, chucks, centers, etc., and a rack for wrenches. There is also fastened to the back of the tray, as shown, an adjustable device for holding blue prints up to 26 by 30 inches. The whole tray is adjustable for height and can be swiveled to any angle, as can also the waste basket and oil can holder.

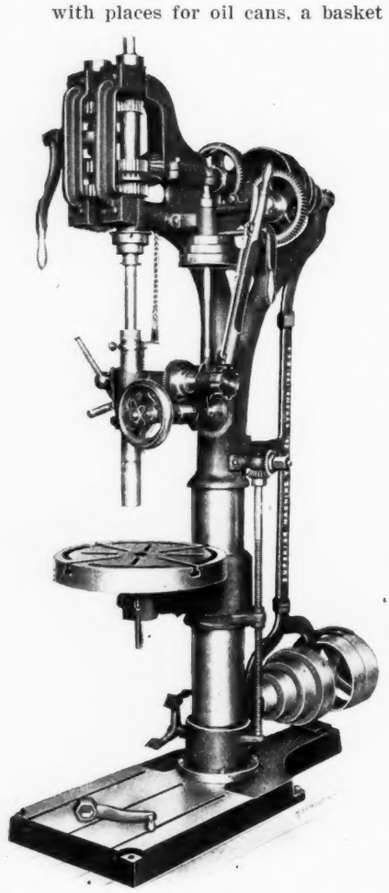


Fig. 1. Superior Machine Co.'s Drill Press with Tapping Attachment

The attaching of this device is exceedingly simple. There are no holes to drill or tap, as a clamp is provided which is tightened to the lower side of the bed with a monkey-wrench, this being the only tool required for attaching the device. The provision of a suitable place for holding lathe tools, wrenches, oil cans and waste within easy reach of the operator, should result in permitting better concentration on the work in hand, and less loss of time and energy. The blue-print holder has been found especially useful in the way of keeping the work continually in front of the operator. It saves the print, as well, from getting torn or soiled from contact with boxes and castings on the work-bench. The illustration shows the tray and stand as seen from the front and back.

THE SUPERIOR MACHINE TOOL CO.'S TAPPING ATTACHMENT FOR DRILL PRESS

The drill press made by the Superior Machine Tool Co., of Kokomo, Ind., was illustrated in the department of New Machinery and Tools of the April, 1907, issue of MACHINERY. This machine was substantially the same as the one here shown, except for the power feed, back gears and tapping attachment, which have since been added. The latter is of unusual interest as it differs radically from the usual construction.

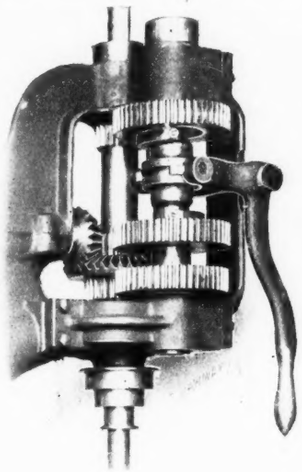


Fig. 2. Tapping Attachment for the Drill Press, designed to prevent Cramping the Spindle

One of the difficulties met with in applying a tapping attachment to the drill press is that of driving a spindle satisfactorily through the short key usually provided on the reversing clutch. This difficulty is met with in the usual construction, in which the clutch mechanism is mounted directly on the spindle. When the load of the tapping operation comes on to the spindle, the strain binds the key so strongly into the keyway of the clutch that if the load is great, it is difficult for the spindle to follow the tap.

With this attachment this difficulty has been overcome. The key and keyway have been greatly lengthened, passing through the full length of the long sleeve shown above the bevel gear. The friction clutches are mounted on a shaft parallel with the spindle. The upper driving shaft is connected by the usual bevel gearing with an idler gear, concentric to the spindle. This meshes with the driving gear on the supplementary clutch shaft (best seen in Fig. 2). On this clutch shaft are loosely mounted two gears, one meshing directly with a mate on the pinion sleeve, the other meshing through an idler. Either of these gears may be connected with the reversing shaft by friction clutches operated by the lever shown. This furnishes means for reversing the spindle for the tapping operation. The key in the sleeve on the spindle extends its full length. On the 23-inch drill this length is 14 inches.

As may be seen, the attachment may be added with practically no alteration in the regular design of drill press.

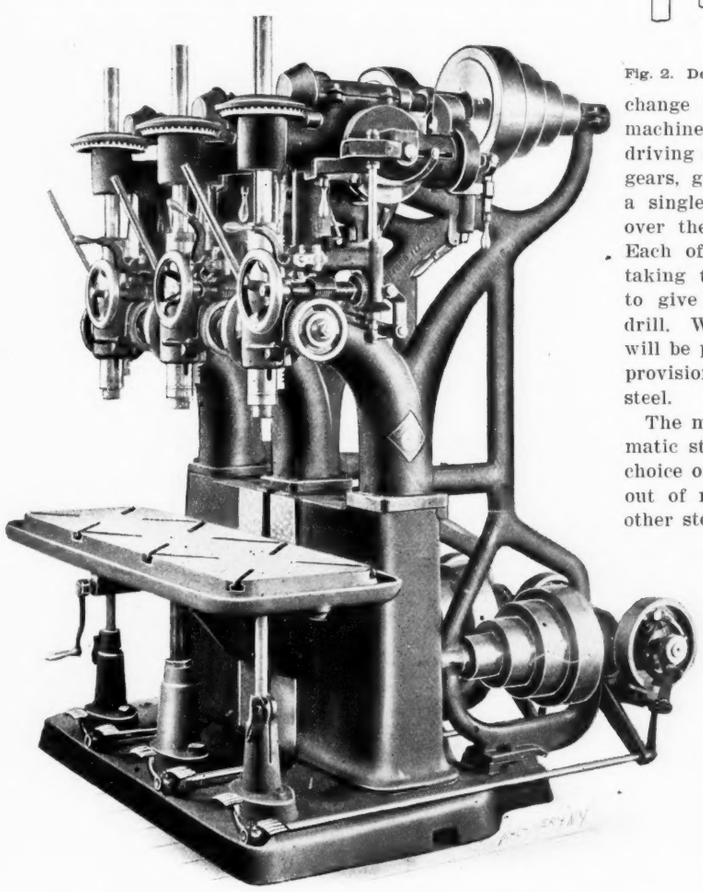


Fig. 1. Gang Drill with Improved Counter-shaft Drive and Feed Mechanism

BARNES 22½-INCH DRILL

The accompanying illustrations show a gang drill built by W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill. This drill is intended for heavy manufacturing service, being equipped with back-gearing, power feed, automatic stop and positive change feed gearing. The counter-shaft at the rear of the machine is driven by a single belt. It is connected with the driving cones of each machine by a friction clutch and bevel gears, giving separate control for each spindle. The use of a single belt drive effects a considerable saving in belting over the usual method of having individual counter-shafts. Each of the main shaft bearings may be adjusted without taking the counter-shaft apart. This drive is proportioned to give the same capacity as the makers' regular 34-inch drill. When desired, however, special three-step cone pulleys will be provided, which will carry a 4¾-inch belt. With this provision the machine will drive a 2½-inch drill in solid steel.

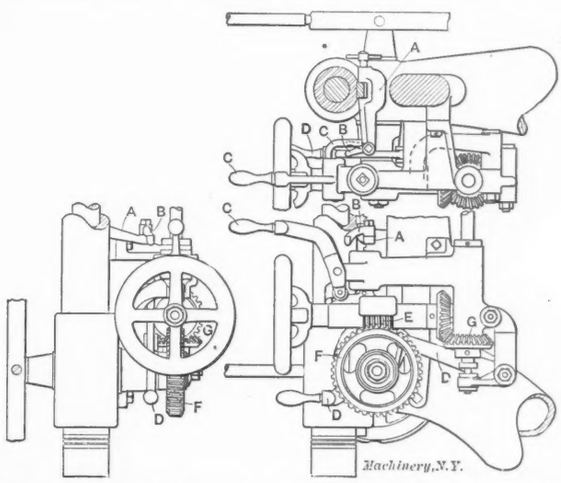


Fig. 2. Detail of Feed Mechanism, showing Double Automatic Stop Motion

The makers call particular attention to the feed and automatic stop mechanism shown in Fig. 2. The operator has a choice of two automatic stops. One of these throws the work out of mesh with the gear on the pinion shaft, while the other stops the main feed by throwing out the miter gear connection with the vertical feed shaft. The automatic stop dog is shown at *A*, clamped to the feed rack on the sleeve. It is provided with a tappet *B*, which may be swung so as to engage either lever *C* or lever *D*. In the top view in Fig. 2 it is in the latter position, its position for engagement with *C* being indicated by dotted lines. Lever *C* controls the engagement of worm *E* with wheel *F*, while *D* operates the throw-out mechanism on bevel gears *G*. The throwing out of the work gearing leaves the spindle free for action by the use of the hand or lever feed at the left side of the spindle. This will be appreciated in such work as requires facing or similar operations at the end of a drilling or boring job. The second throwout is the one more commonly used, but it does not leave the spindle free for motion, as worm *E* and gear *F* are still engaged after the feed is tripped.

The provision for back-gearing and the positive geared feeds will be readily seen in Fig. 1. The whole construction gives

evidence of possessing the power and rigidity required for the heavy manufacturing work the machine is intended to handle.

SELLERS CAR-WHEEL LATHE

A test to demonstrate the extraordinary power and speed of a new car wheel lathe was made in the works of William Sellers & Co., Inc., Philadelphia, May 15, before a large company of railway officials, mechanical engineers and others interested in improved railway machine tool design. Four pairs of steel tired wheels were turned, three pairs being nominally 36-inch coach wheels, and one pair 33-inch engine wheels. The accompanying log of the performance is a record that impressively shows the great advance made possible in tire turning by the new high-speed steels, when a machine is provided capable of utilizing them to the limit of capacity and an operator is available who can handle the machine with skill and energy.

Fig. 1. Sellers Car-wheel Lathe with Tool Turrets

The average official time for turning each pair of 36-inch wheels including the time required for placing the wheels in the lathe and removing them to the floor, or "from floor to floor," was 19.11 minutes. The time in the table is expressed in minutes and decimals, 19.47 minutes being 19 minutes and 28 seconds, and so on. The replacing of a burned tool required 27 seconds, which deducted from the total time leaves 72 minutes 1 second required for four pairs of wheels, floor to floor. This time does not include that required for changing the lathe for the last pair of wheels, which was just six minutes. On ordinary practice the operator would not change from outside to inside journal wheels pair by pair but would group the wheels so as to turn all of a kind or size in a lot. The steel used for roughing and finishing tools was "Novo Superior." The operator was Mr. William Anthony of the P. & R. Ry., Reading, Pa., shops.

Characteristics of Lathe

The lathe which is shown on the operator's side in Fig. 1 is designed to turn all kinds of steel-tired car wheels from 28 to 42 inches diameter, whether of plate or spoke center type. The machine as a whole and the bed especially are of massive construction as will be inferred from the weight which is 72,000 pounds. The headstocks have extensions on which the tool rests are mounted. The left-hand head-stock is fixed on the bed and the right-hand head-stock is traversed by power, an independent motor being provided for this purpose. The connection of the motor to the gearing is through a clutch that is adjusted to slip in case a solid obstruction is met by the head-stock in its traverse. The traversing motor is capable of exerting a pressure of 55,000 pounds through the head-stock against the wheels, and this power is utilized to sink the driving dogs into the tires when setting the wheels in place.

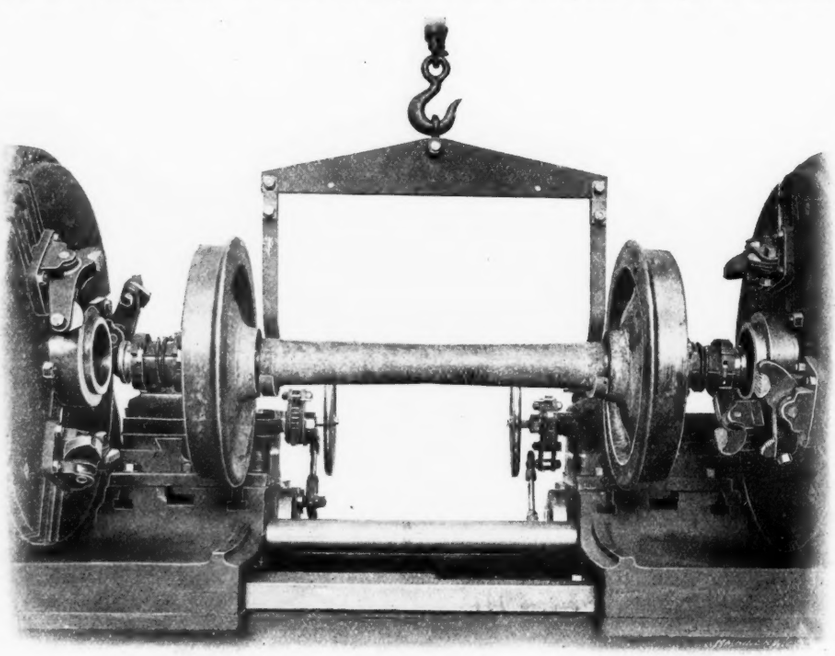


Fig. 2. Turned Wheels being lifted out of Lathe. Note Faceplate Drivers, Bushings on Journals and Tracks cast on Headstock Extension to match Shop Track

In its characteristics the machine is quite similar to the tool turret driving wheel lathe, illustrated and described in the June, 1908, number of MACHINERY. On this car wheel lathe, however, the tool turrets are square, having provision for four tools, and the indexing and locking mechanism are

simplified. The face-plate driver also differs, it being necessary to provide means by which the wheel can be driven by gripping the outer edges of the tires only. Another essential difference is the means for centering and supporting the axles of coach wheels and other car wheels having outside journals. Three-part taper bushings held assembled by two turns of a weak coiled spring are used, these bushings being slipped over the journals before rolling the wheels into place. The bushings enter the taper mouthed spindles in the head-stock and thus center the wheels by the journals. A coiled spring in the movable head-stock forces its spindle forward and

TEST OF SELLERS CAR-WHEEL LATHE

	Wheels 1	Wheels 2	Wheels 3	Tank Wheels 4
Diameter of wheel, rough, inches	35 1/8	34 15/16	35 1/4	33
Floor to chuck, minutes	1.05	1.66	1.18	1.2
Rough turn, Rough flange, Finish flange and tread, Finish chamfer, minutes	17.8	16.02	18.17	13.55
Machine to floor, minutes	0.62	0.77	0.65	0.4
Total time, minutes	19.47	18.45	19.40	15.15
Average cutting speed in feet per minute	15–16	16	14	19

"weighs the load," keeping a constant pressure on the bushings and journals, and holding them firmly against the pressure of any cut that the machine is capable of taking. For engine truck wheels having the journals between the wheels, pointed centers and bushings are provided to fit the taper holes in the spindles. The center points support the axle centers in the usual manner of common shaft turning.

The lathe equipped as shown in Fig. 1 has an overhead trolley track composed of two channel section beams rigidly secured to the upright springing from the fixed head-stock. The opposite ends are supported on friction wheels fixed to the upright springing from the movable head-stock, this

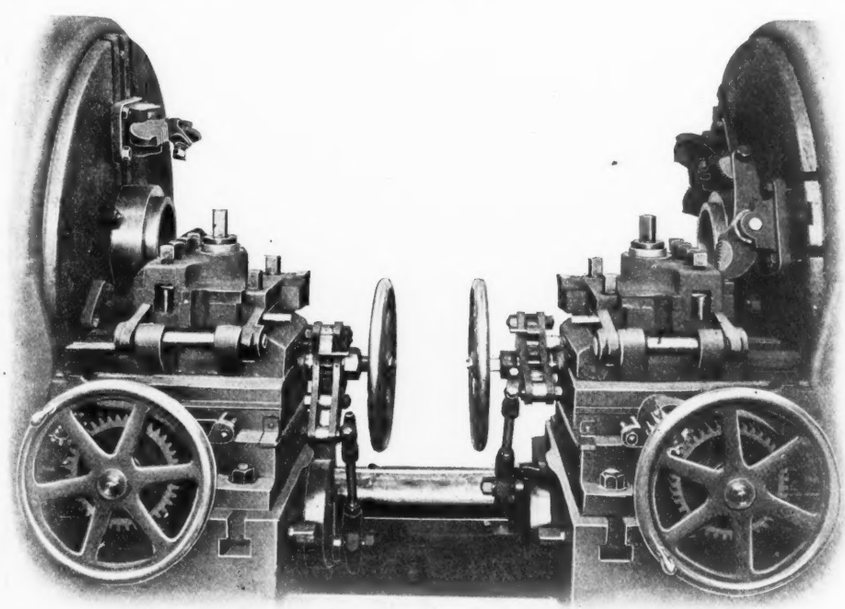


Fig. 3. Turret Tool Heads and Carriages, Sellers Car-wheel Lathe

arrangement being necessary on account of the traverse of the movable head-stock. The trolley carries an air cylinder and tackle for lifting and lowering the wheels; no crosswise movement of the trolley is provided or needed. Short tracks are cast on the feet of the tool carriages as shown in Fig. 2, which match the shop rails, thus providing support on which the wheels are easily rolled under the trolley, and out again when turned. During turning of the wheels the trolley tackle is not disengaged from the axle, but is simply lowered so as not to be in contact with the axle.

Turret Tool Heads

The turret tool heads shown on an enlarged scale in Fig. 3 are noteworthy because of simplicity of design and effectiveness of action, aside from the fact that turret tool heads are provided on a lathe of this character. The need of means for easily and quickly changing from roughing to flanging to

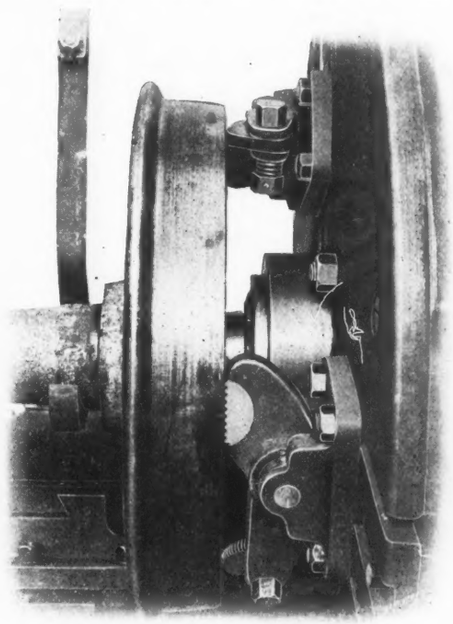


Fig. 4. Faceplate Driver engaged with Tire

finishing tools has been apparent to those who have watched the operation of a modern wheel lathe equipped with the common four-bolt type of tool-post, when the lathe is pushed to the limit of its capacity. The labor of changing tools is exhausting, and the time required retards the production of turned tires. The present car wheel turret tool head is not as highly developed as the driving wheel lathe turret tool head previously described. The operator has to lock and clamp the turret by independent movements, whereas in this one all these functions are performed with one lever. The locking mechanism of the car wheel lathe turrets comprises two cams for each turret mounted on a short shaft supported in the bearings forming a part of the tool head support. The cams bear against the side of the square turret near the corners, thus locking it at the points furthest removed from its center of rotation. The cams are worked by a crank and the turret is turned by a wrench engaged with square bolt heads on the turret at or near each corner. The center bolt clamps the turret rigidly in place. The roughing tool is made of bar stock and is placed in a through slot, where it is clamped by four screws. The finishing tools are short sections and are mounted on ledges cast on the sides of the turret, where they are held in position by filister head screws.

Automatic Toggling Drivers

Three toggling drivers of the form shown in Fig. 4 are mounted on each face-plate, and drive by the engagement of serrated semicircular blocks forced into the edges of the tires. The drivers are mounted loosely on a pin near the center of the lever, and heavy trunnions support the thrust, the pins only acting to hold the levers in place. At the opposite ends of the levers are cams with teeth. When the

wheel is brought into position the traversing motor forces the toothed blocks in the face-plate drivers into the tires, thus making initial engagement. The cams are then forced against the tires by wrenches fitting the hexagon head pins on which the cams are mounted. The cams force the steel blocks in the opposite ends of the drivers still further into the tire, and should the wheel slip, the cams roll on the tire

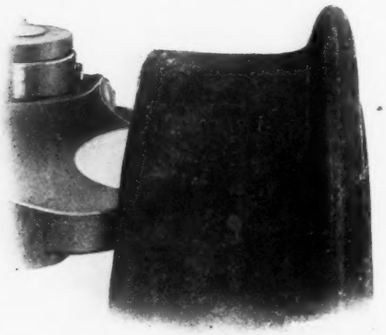


Fig. 5. Worn Tire as taken out of Service

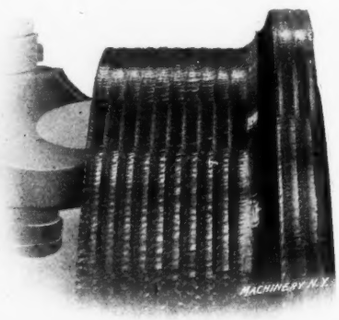


Fig. 6. Roughing Cut on Tread and Flange Completed

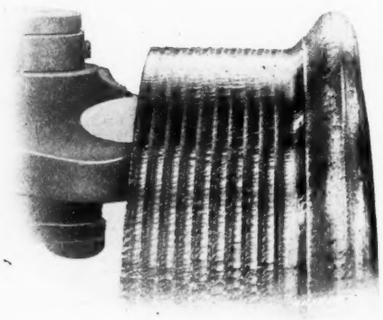


Fig. 7. Flange Roughly Formed

forcing the serrations deeper and deeper into the tires, and effectually stop further slipping. Practically no evidence of slipping is noticeable, the first engagement being sufficient to drive. Each block has eight or nine serrations, and the depth the teeth sink is only about 1/32 inch.

Controlling Apparatus

The lathe is driven by an adjustable speed motor of 25-30 horse-power, and is controlled by an automatic solenoid switch

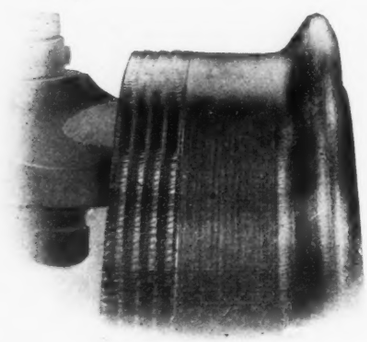


Fig. 8. Flange and Tread Finished

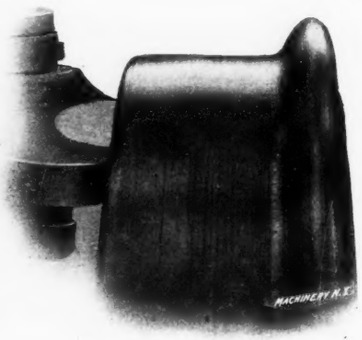


Fig. 9. Tread Tapered and Corner Chamfered; Tire Finished

panel. The push button pilot switches are located in a position convenient to the operator. By the use of these switches he is able to start and stop the machine and reduce to an extremely low speed without stopping when required for passing hard spots. After the hard spots have been passed the lathe will resume the speed at which it was running by merely releasing the slow down switch. The perfect control of the cutting speed thus obtained has a marked effect on the productive capacity. Were it not possible to run the lathe at the slow speed necessary when cutting hard spots, the production, of course, would be much less than that possible when the maximum speed is used except when hard spots are being cut out.

Order of Operations

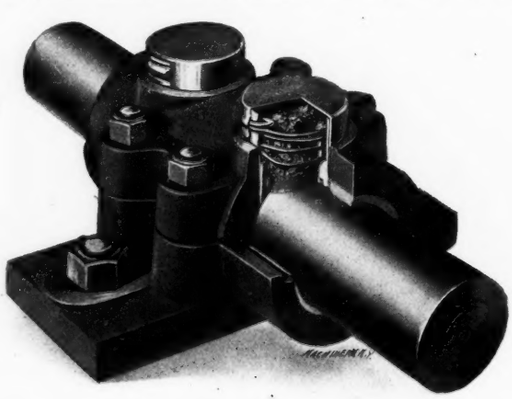
Figs. 5, 6, 7, 8 and 9 show the various stages from the worn to the finished tire. In Fig. 6 the roughing has been completed. The roughing tool has passed over the tread and flange with a feed of $\frac{3}{8}$ inch and depth of cut of about $\frac{1}{2}$ inch. In Fig. 7 the rough flanging tool has been brought into position and the corner of the tire roughed to shape. In Fig. 8 the finishing flanging tool has turned the flange and tread to shape, and in Fig. 9 the tread has been tapered off and the outer corner chamfered at one operation. Notwithstanding the speed at which the wheels were turned in the test, the appearance of the finished wheels was good and tests of diameters and contours left nothing to be criticised.

VAN DOREN AUTOMATIC SHAFT LUBRICATOR

The shaft bearing shown in the accompanying engraving is fitted with a Van Doren automatic lubricator, using grease as the lubricating medium. The method of lubrication insures the constant feeding of the material to the shaft at just the right rate to agree with the requirements, this being done automatically so long as the supply holds out; the device is thus very economical in the use of the grease. The C. J. Van Doren Co., 5 West Madison St., Chicago, Ill., is the manufacturer.

As shown in the engraving, this oiler comprises a metal shell or barrel fitted into the bearing cap, a cap covering its upper end, a spring, and a wooden gland. The distinctive feature of the apparatus is this wooden gland, which is forced by the spring down onto the shaft, conforming exactly to its contour. As shown, it is hollow and filled with grease, which lies on the shaft. A ring of felt packing in a circular groove cut in the bottom of the gland furnishes a smooth bearing surface and prevents the generation of any surplus friction on the wood, keeping the shaft wiped clean as well, and allowing only enough grease to escape to give proper lubrication. The spring holds the gland in contact with the shaft, the thrust being taken in slots in the barrel serving also as a locking device for the cap. The bearing should be drilled so that the barrel will fit snugly in the hole, where it is held in place by staking or calking the edge with an offset center punch. On ordinary bearings up to 4 inches in diameter and 12 inches long, two lubricators are necessary. For larger sizes and for extra heavy work more may be required.

The gland allows just enough grease to be taken away to make a proper coating for the shaft, and no more. It keeps



A Lubricator for Supplying Grease in the Exact Quantity required

the surplus always taken up. If for any reason the bearing should begin to heat slightly above the normal, the lubricant lying directly on the shaft has a tendency to run more freely,

and so supply the extra amount needed until the bearing is restored to its normal condition. It might be expected that this melting of the grease from the heating of the bearing would occur suddenly, and would continue until all of it had been carried off. Such a provision would make the principle of the device impracticable. In use, however, it is found that the rise of temperature and the consequent softening of the grease is held under absolute check.

The advantages claimed for these bearings are numerous. They are inexpensive, easily applied and economical in the use of the lubricant, giving practically perfect lubrication at a nominal cost. Their cleanliness is also a strong point in their favor. It is unnecessary to provide drip pans, guards, or similar devices for keeping the machine and surrounding floor and ceiling clean, the lubricant being supplied so slowly that trouble on this score is obviated. The use of grease as compared with oil is objected to by some mechanics, but it is stated that lubricants of this character are now made having a coefficient of friction as low as those of the oils.

The economy derived from the use of this grease cup relates not only to the small supply of lubricant used as compared with the usual method of flushing with an oil can, but is important on the score of labor cost as well. One man can tend to a great many more bearings than is possible where liquid lubrication is employed. There is also said to be considerable economy in repairs and re-babbitting, due to hot boxes and similar causes. The makers of this device stand ready to send it on trial to responsible parties having use for such devices in their work.

MULTIPLE SPINDLE DRILL WITH VARIABLE SPEED DRIVE

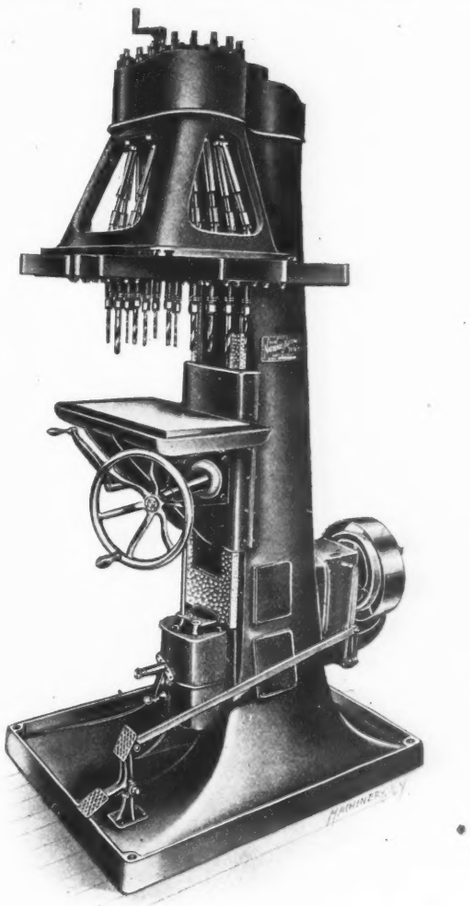
The weakness in the construction of the usual type of adjustable multiple spindle drill press is the fixed driving ratio between the different spindles, which require all to be run at the same rate, irrespective of whether a large or small hole is being drilled. The machine illustrated herewith, built by the National Automatic Tool Co., Ice Avenue and St. Clair Street, Dayton, O., is designed to overcome this difficulty. Each drill and tool may be revolved at its proper cutting speed. This is effected while still preserving the wide range of action, rigidity of construction and the close center distances which are expected on a machine of this type. The practical result obtained is an increased output on work having holes of different diameters.

Maximum Output

The power is delivered by a friction pulley through a change speed box and bevel gears to the main vertical shaft in the column. Five cone gears on this main vertical shaft in the head, by means of three separate series of compounds and idler gears, deliver the power to each independent spindle gear. These cone gears are thrown into commission by means of three sliding keys located in the shaft. One key engages the lowest gear, the next key the other two gears and the third, the remaining two gears. Thus three of them can be in commission at the same time, and deliver their respective speeds to the spindle driving gear. The combinations possible are 500, 750, 2,000; 500, 750, 1,500; 500, 1,000, 1,500; and 500, 1,000, 2,000 revolutions per minute respectively for the spindle driving gears. In addition to these triple combinations, any one of two speeds of those above given can be obtained on the spindle driving gear. Thus if only one size drill is being used, none of the other cone, compound and idler gears revolve if the sliding keys in the shaft are disengaged. These changes, together with the three in the speed boxes and those in the feed box will give any combination needed.

The spindle driving gears are keyed to their respective driving shafts by means of a bronze gear fork, through one end of which a spindle shaft runs and to the other end of which a screw is connected. The spindle driving gear is thus quickly raised or lowered for three different speeds or three neutral positions. By this means such spindles as are not in use can be placed in the neutral position and remain idle, thus saving wear on all the spindle parts. The screws are operated from the top of the machine, and indicators on each show exact position of the spindle driving gear within the head. With the initial speed in the change gear box fixed, any desired spindle speed can be obtained independently by the raising or lowering of the respective spindle gear within the head. One-sixteenth, 1/8, 1/4, 3/8 and 1/2-inch drills can be run side by side, each at its proper cutting speed and maximum feed.

Ball races are placed between all the main driving, compound and idler gears in the head. Ring oilers are used in the speed boxes. Ball thrust bearings are provided at the top of the vertical shaft bearing in the column. All the gears are cut from the solid, and those in the head, feed box and speed box, and on the vertical shaft within the head, run in an oil bath. An oil pump keeps a continuous circulation of oil within the column on the change gear box. The bushings in the idler and compound gears in the head are hardened and ground and run on hardened and ground studs. The adjustable rails are made of cast steel, and are sufficiently rigid to prevent deflection of the drills even under the stiffest feeds. The spindles are of tool steel and run in hardened and ground bushings. Adjustment for different lengths of drills is provided within the spindle.



A Multiple Spindle Drill, in which the Speed of Individual Spindles can be varied

Attention is called to the unique construction of the universal joint. The cube and its four connecting pieces are made from a solid block of metal, thus obviating the use of screws for connecting the cube and the driving sides. All the wearing surfaces are hardened.

The work-table has a large oil groove and is so constructed that T-slots can be cut in it. It has a large bearing on the column, is counter-weighted and has both hand and power feed. There is a 16 1/2-inch vertical adjustment between the end of the largest drill and the top of the table.

Speed Box

Three rates of feed are provided in the feed box, giving 1 1/2, 3 and 4 1/2 inches of movement per minute respectively. An automatic knock-out for the table feed is provided. An

oil pump and a large reservoir for the lubrication of the cutting edges of the drills is provided on this machine. This multiple drill is made in a number of different sizes, with a squared head carrying up to 12 spindles, and a rectangular head carrying up to 20 spindles.

LODGE & SHIPLEY LATHE WITH AUTOMATIC FEED STOPS

A patent head, quick-change gear engine lathe, as manufactured by the Lodge & Shipley Machine Tool Co., of Cincinnati, Ohio, is shown in Fig. 1. This lathe, as seen in the engraving, is equipped for machining malleable iron hubs for automobiles, two of which are shown on the floor beneath the machine. The particular feature, aside from the automatically revolving turret, which adapts this machine to work of this kind, is the arrangement of automatic stops which control the longitudinal movement of the carriage and the movement of the cross slide. The stops for controlling the length of the carriage travel, are seen mounted on the left end of a bar on which they are free to slide, which extends along the front of the bed. By varying the positions of these stops, which telescope into one another as shown, shoulders of any desired length can be obtained, for as the lever attached to the left end of the apron comes against one of these stops, the bar upon which it is mounted is given a slight longitudinal movement to the left thus throwing a clutch which disconnects the lead screw from its driving gears. A more complete description of the way in which these stops control the movement of the carriage travel will be found by referring to the article descriptive of the Lodge & Shipley crank-shaft lathe in the New Machinery and Tools department of the June number. The diameter gage, which is shown to the right of the cross slide in Fig. 2, consists of a slotted drum carrying adjustable stops that control the cross travel of the compound rest and stop the tool at any desired point. By turning this drum, different stops are brought into alignment with the tappet in the cross slide and in this way the stop is quickly set for different diameters.

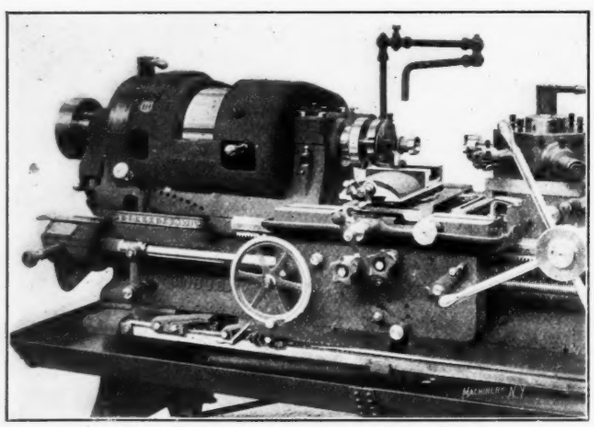


Fig. 2. View showing the Stops more in Detail

By way of illustrating the usefulness of this combination of automatic stops, a brief description of the various steps in machining automobile hubs, for both the front and rear wheels, will be given. The front hubs shown in Fig. 1, are 5⅛ inches in length, 5½ inches in diameter across the flange and 2½ inches in diameter on the small end which is threaded. The rear hubs are similar, the main difference being that they are faced on both ends, finished more completely on the outside and have a ball race at one end only.

For the first operation on the front hub, the lathe is provided with special reamers, boring jigs and a 15-inch combination chuck. The hub is held with the flange against the chuck jaws, as shown in Fig. 1. The turret operations comprise boring a straight hole through the hub with a four-lip drill, boring the seat of the ball cup and reaming the seat of this cup. While the tools of the turret are in operation, the compound rest tool faces the end. This completes the first operation, and prior to the second, the holes in the flanges are drilled.

In Fig. 2, the method of holding and driving the work, and the equipment for the second operation is shown. The hubs are first mounted upon an expanding straight mandrel, which is inserted in the lathe spindle. The drive is from a pin which fits into a drilled hole in the flange. A seat for the ball cup is first bored and reamed, the correct depth being positively obtained. While the turret tools are performing this operation, the tool on the compound rest is facing the flange, its inward movement, of course, being controlled by

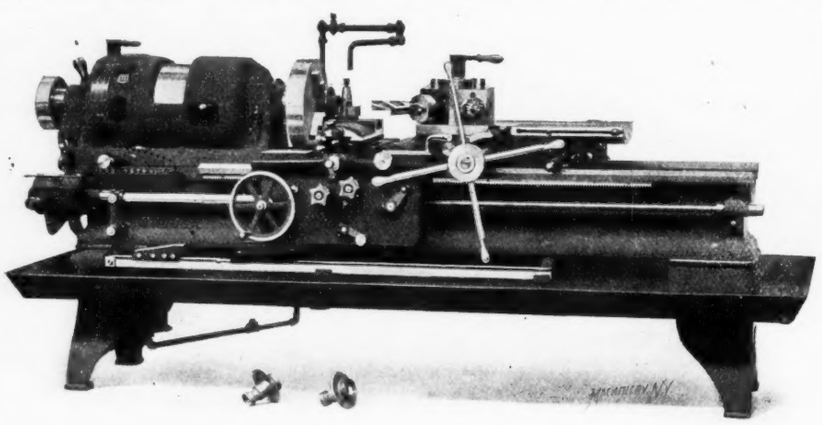


Fig. 1. Lodge & Shipley Lathe equipped with Automatic Stops for Controlling the Longitudinal and Cross Movements of the Turning Tools

the automatic stop referred to. The barrel of the hub is also turned, and the various diameters are positively obtained by means of the diameter gage. Cutting the thread completes the machine work for the front hub.

During the first operation on the rear hub, it is held in the chuck with its flange against the jaws, practically the same as shown in Fig. 1. The turret tools first bore and ream the seat for the ball cup and also face a seat for the dust washer. Simultaneously with these operations, the compound rest tool faces the brake pan on the flange and turns the flange diameter, all diameters and lengths being obtained from the positive stops. After the flange is drilled as in the first case, the hub is mounted upon a straight arbor, which is located in the hole of the lathe spindle, for the second operation. The work is additionally supported by a bar carried in one of the turret holes which makes coarser feeds and faster cutting possible and also gives truer work. All of the remaining operations are then performed by the tool in the compound rest.

IMPROVEMENTS IN WATSON-STILLMAN HYDRAULIC JACKS

One of the regular line of lifting jacks built by the Watson-Stillman Co., 192 Fulton St., New York City, has been provided with truck wheels and a handle to facilitate moving it from place to place. The wheels touch the floor only when the jack is tilted so they are not in the way during lifting operations. It can also be used in an angular position or flat on its side, without interference. This jack is made in eleven sizes, from 20 to 50 tons capacity, with lifts of from 12 to 18 inches, filling all the ordinary requirements of general shop work.

This firm has for some time built a jack in which the pump is separate from the ram, being connected thereto by flexible copper piping. This construction is convenient where it is difficult to work the lever of the usual apparatus, from lack of room or insufficient footing. This tool also requires much smaller head room than when the pump is included in the same mechanism. This jack has been re-designed and built from new patterns. An added improvement is furnished,

if desired, in the shape of a gage, which is not needed for ordinary lifting, but is useful in adapting the jack to testing purposes. When so equipped it may be used between two fixed platens for making compression tests, testing the tightness of forced fits, etc. The gage will be furnished to read in pounds per square inch, or in tons load upon the jack, or both as required. These jacks are furnished in fifty-three sizes, ranging from 2 to 1,200 tons capacity. The rams of the various sizes have movements of from 4 to 8 inches.

MOORE & WHITE AUTOMOBILE CLUTCH

In Fig. 1 is shown a half-tone, and in Fig. 2 line drawing details, of an improved friction clutch of the multiple disk variety made by the Moore & White Co., 15th St. and Lehigh Ave., Philadelphia, Pa. While intended particularly for automobile work, this clutch should have a wide application for other similar uses. As designed for automobile use and as shown herewith, the clutch is contained within the balance wheel *A* of the motor; the inner cover *B* fastened to this balance wheel forms with it an oil reservoir in which the disks *C* are constantly immersed, thus being absolutely self-oiling and free from danger of destructive wear.

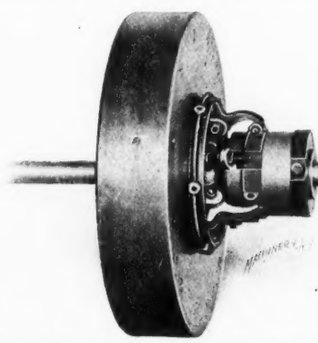


Fig. 1. A Multiple Disk Clutch especially adapted for Automobile Work

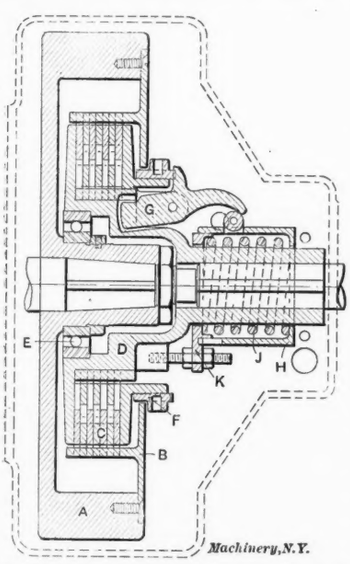
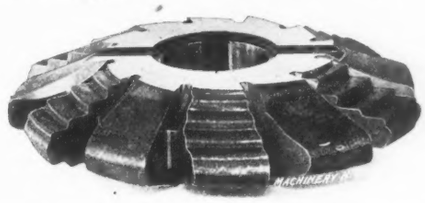


Fig. 2. Detail of Clutch, showing Engaging Mechanism and Provision for Oil Bath

The disks *C* follow the usual construction of clutches of this type in being keyed alternately to the balance wheel *A* and to the driving spider *D*. The latter is keyed to the driven shaft, which is supported in the wheel on ball bearings *E*. The engaging device and the means for maintaining the pressure are extremely simple and powerful. The clutch is normally in its engaged condition, the disks being forced together by springs *J*, under a pressure determined by the adjustment of the ring *K*. For disengaging the clutch, sliding sleeve *H*, through the action of levers *G*, releases the pressure of spring *J*, so that the alternate disks revolve loosely on each other, and no motion is transmitted from the balance wheel to the driven shaft. An adjustable abutment for levers *G* is provided at *F*. As the rings wear, this is screwed up to keep the parts in their proper relative positions.

BROWN & SHARPE STOCKING GEAR CUTTER

The formed cutter shown herewith is intended for stocking and roughing out the teeth of gears. It is of unusual construction, as may be seen, in that it is made up of alternating plain and stepped teeth. This construction has the advantage that it closely conforms to the shape of the finished tooth space, thus leaving little to be removed by the finished cutter; and at the same time breaks up the chip, so that high speeds and feeds can be used without subjecting the cutter to great strains or heating. It is superior in this respect to both the plain formed cutter and to the design in which all the teeth are stepped.



A Stocking Cutter with Alternating Plain and Stepped Teeth for Breaking the Chip, made of either Tool or High-speed Steel

The cutter shown is an unusually large one, being 13 inches in diameter and being intended for cutting teeth of 1 diametral pitch. In spite of its size, the way in which the chips are produced enables heavy cuts to be taken without undue strain on the teeth or the driving clutches.

MOORE & WHITE VARIABLE SPEED DRIVE

An interesting variation of the taper cone pulley type of speed changing mechanism, built by the Moore & White Co., 15th St. and Lehigh Ave., Philadelphia, Pa., is shown herewith. Instead of running the belts directly on the tapering surface of the cones, short supplementary belts are provided, built up of tapered segments, which furnish true cylindrical

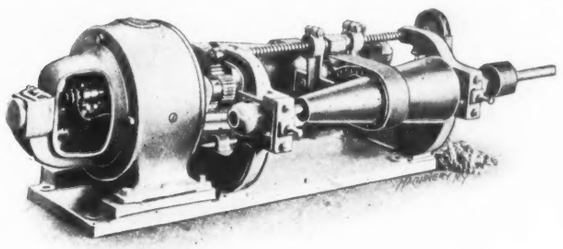


Fig. 1. Variable Speed Counter-shaft of the Taper Cone Type, giving Cylindrical Belt Contact

surfaces for the connecting belt to run on. The speed is changed by means of a belt shifter which receives its movement from a screw actuated by any suitable means, though usually by a chain and sprocket wheel from the operator's position. The belt shifter, thus operated, moves the supplementary belts and the connecting belt toward the large or small end of the driving cone, thus increasing or diminishing the speed of the driven cone. This device was originally brought out for use in paper mill machinery, where very

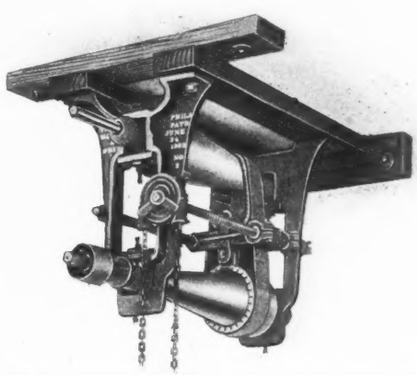
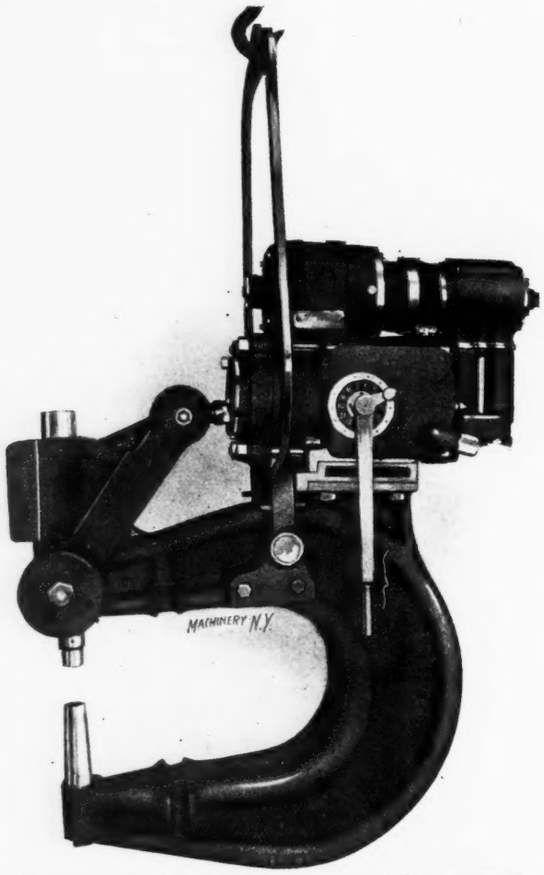


Fig. 2. Vertical Arrangement of the Counter-shaft for Compact Wall Use

fine gradations of speed have to be obtained while transmitting great horse-power; it has now been developed in smaller sizes for use in machine tool drives. A very convenient and compact form of the device is shown in Fig. 1. This takes up little more space than the ordinary counter-shaft. A still more compact arrangement, suitable for attachment to the wall, is shown in Fig. 2.

RYERSON INTERNAL COMBUSTION RIVETER

One of the most interesting of the many machines and appliances shown at the June conventions of the American Railway Master Mechanics' and Master Car Builders' associations at Atlantic City was an internal combustion portable riveter made and sold by Joseph T. Ryerson & Son, Chicago. The principle of action of this riveter, which is applicable to many other machines in which the work is done by rectilinear motion, including punches, shears, bulldozers, etc., eliminates the power plant necessary for compressed air, hydraulic, or steam riveting installations, the power plant of each riveter being self-contained. An explosive mixture of air and any gas commonly used to operate gas engines is



Ryerson Internal Combustion Riveter for Steel Cars, Structural Work, etc.

pumped into the work cylinder, thus forcing the dies against the hot rivets, and when a predetermined pressure has been reached the charge is automatically fired and the rivet set. The only outside power required is that necessary for operating the charging pump and firing the charge. This may be supplied, if required by the conditions of the work, from a storage battery.

The riveter in general appearance resembles the ordinary C-frame riveter in common use. It has a toggle action by which the pressure on the rivet dies is increased as the end of the stroke is neared. The piston is directly connected to the toggle action, and on top of the cylinder is mounted a small electric motor and direct-connected pump for charging the mixture of air and gas into the explosion chamber. On the side of the cylinder is the operating lever, and mounted on the same spindle is a pressure controlling handle by which the pump pressure is predetermined. The dial is numbered, each number representing an atmosphere or 15 pounds (nearly). If the indicator is set at, say, seven atmospheres, the charge will automatically explode when the pump has charged the cylinder to a pressure of about 105 pounds. The rise of pressure forces the dies firmly against the rivet so that the full power of the explosion is exerted in setting the rivet. As the charge is fired, the pump motor is cut out so that consumption of electric power is confined to the time actually required to charge and fire.

The piston is automatically returned by means of a coiled spring in the hub of the toggle links. The operation of charging, firing and releasing requires about one second on light work. On heavy work the time is longer, it then being necessary to hold the dies on the rivet for a short period. The dies are held against the rivet by simply waiting the desired time before moving the lever operating the exhaust valve. However, on steam-tight work, where the dies must be held for some time in order to let the rivet cool and thus grip the sheets with the utmost firmness, a hydraulic cylinder is interposed between the gas cylinder and the die, by which the pressure can be held indefinitely. This auxiliary cylinder for steam boiler work is necessary because of the fact that gases cool rapidly and reduce the pressure. The gas piston on the riveter shown which is designed for riveting steel cars, structural work, etc., is air cushioned, there being ports drilled in the cylinder head of the piston which are closed by the piston in its travel, and thus air is entrapped to act as a cushion to reduce the shock of the explosion and prevent knocking out the head in case the charge should be fired with nothing between the dies.

The machine is operated by a single lever the same as an air machine, and can be worked in any position. It is simple in construction and operation, and the upsetting action on the rivet is much quicker than in compressed air, steam or hydraulic machines. It is claimed that the necessity of uniform heating of rivets is obviated as the operator has absolute control of the pressure and may readily gage it to suit the heat of each rivet. The riveter will drive any commercial size rivet and requires approximately one gallon of gasoline for four thousand ¾-inch rivets.

MILLING ATTACHMENT FOR THE ACME MULTIPLE SPINDLE SCREW MACHINE

A simple, compact and time-saving device for finishing duplicate parts requiring milling or slotting, has recently been designed for use on the Acme multiple spindle automatic screw machine, manufactured by the National-Acme Manufacturing Co., Cleveland, Ohio. This is one of a number of

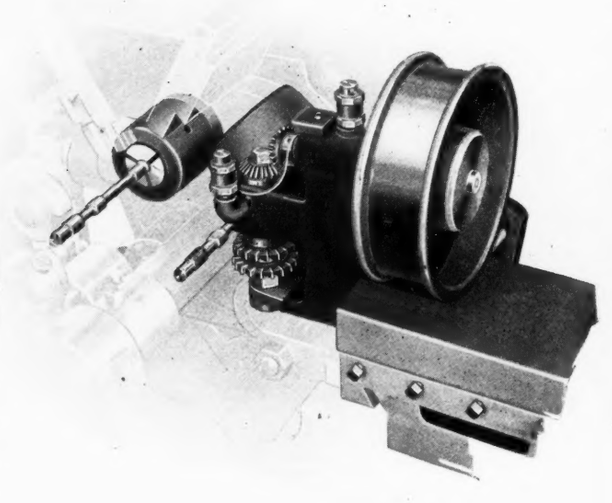


Fig. 1. An Attachment which enables Work to be milled in the Automatic Screw Machine, thus eliminating a Second Machining Operation

attachments recently designed for this machine for eliminating the rehandling of parts for the purpose of drilling, milling, slotting or countersinking them.

This attachment, which is shown in Fig. 1, is fastened to the top of the slide which carries the cutting-off tool. The engraving shows it arranged for milling the flat part on the piece shown in Fig. 3. This cold rolled steel piece is being made in the factory of the Cadillac Motor Car Co., of Detroit, at the rate of 53 pieces per hour. This number also represents the maximum output when the pieces are not milled. By the previous method of making these parts, less than one-

third as many per hour were produced, and milling the flats constituted a second operation. It will thus be seen that the entire cost of rehandling is saved by the use of this attachment. The way in which it is attached to a regular machine, and its general construction, will be seen by referring to the engravings. For milling the piece shown in Fig. 3 two mill-

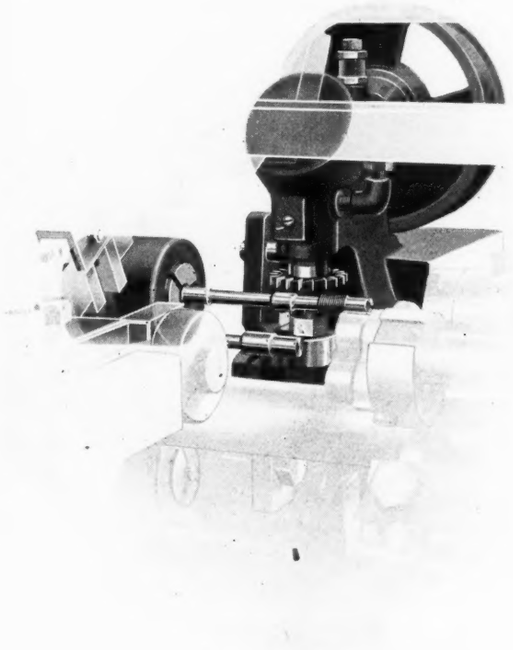


Fig. 2. Another View of the Milling Attachment

ing cutters are set the required distance apart on the vertical arbor which is driven by bevel gears, which connect with a horizontal shaft carrying the driving pulley. This pulley receives its power through a belt from a "Simpul" countershaft. The feed of the cutters is controlled by the cutting off cam, and the increased movement necessary is obtained by an auxiliary lever, which is seen to the left of the attachment in Fig. 2. This lever connects with the top cross slide which is dove-tailed to the slide beneath it. This second slide is also dove-tailed to the slide upon which it rests, and by its longitudinal movement, the cutters are adjusted to the proper location.

Fig. 3. An Example of the Kind of Work to which the Attachment is adapted

The milling operation upon the work takes place while it is in the third position, and at the same time that the thread is being cut. While this operation is taking place, the forming and box milling tools are at work in the first position. In attaching this device to a regular machine, it is only necessary to drill and tap two holes in the top of the cutting-off slide upon which the attachment rests. It is possible to drive this attachment without employing a special countershaft, by directly connecting it to the die spindle gears in the main tool slide, by a telescoping shaft, knuckle-joints and bevel gears. This makes it possible to drive the machine with a single belt or motor without any special over-head arrangement for the attachment.

MUMFORD WIRE BELT LACING DEVICE

Wire lacing for belts has of late years become the standard method of belt fastening in large establishments. The operation consists essentially of threading a coil of wire into the edge of each belt, flattening these coils down, interlocking them on the two edges and inserting a raw-hide pivot or pin to complete the hinged joint. About the only objection to this process in the ordinary shop is the expense of the apparatus required for coiling and inserting the wire. Mr. Harry T. Mumford of 258 West 22d St., New York City, has invented and is placing on the market a device of great simplicity for performing this operation; it is so inexpensive that the smallest shops can afford to use it. This device is shown in use in Fig. 1.

A nickel and polished pattern plate is the essential feature of the invention. Into this the edge of the belt to be laced is placed, being held there by inserting two thumb tacks through holes in the upper lip, as shown. With the awl which is furnished with the outfit, the operator then pierces holes through the belt at the bottom of the slots formed in the turned up lip of the pattern plate. After all the holes have been pierced,

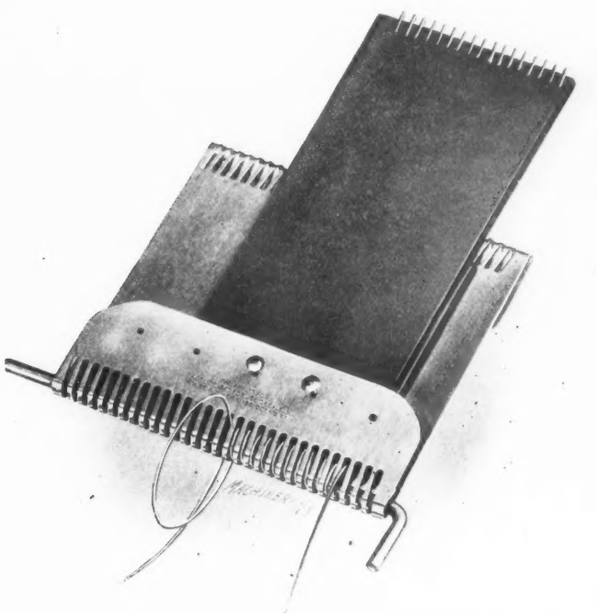


Fig. 1. An Inexpensive Tool for Inserting Wire Belt Lacing

a steel wire is threaded through them in helical form, over the wire mandrel which lies inside the lip of the plate, as shown. Fig. 1 shows this threading of the wire partly completed. After threading, the belt is removed from the plate and the mandrel removed from the belt. Then the wire lacing is squeezed in the vise flat and even with the belt, or pounded down flat on the bench. The ends of the wire are caught in and clinched to prevent them from loosening.

The pattern plate is next reversed, and the other end to be joined is inserted in place. The slots on this other end of the plate are reversed, so that one of the wire coils will be

Fig. 2. The Rest of the Equipment Furnished with the Belt Lacing Device shown in Fig. 1

right hand and the other left. This is necessary to permit them to interlock. The same operation of threading and pounding down is repeated with this end of the belt. The two ends may now be brought together with the coils interlaced, when a raw-hide pin or pivot is inserted, thus locking the joint, but leaving it hinged and flexible so as to be adapted for use on the smallest pulleys.

The outfit provided includes besides the pattern plate, awl and mandrel just described, a set of raw-hide pivots, a supply of wire lacing, extra awl points, thumb tacks, etc. This extra material is shown in Fig. 2. The plate may either be held in the vise, an attachment being provided for that purpose, or it may be held to the bench by means of buttons, also furnished with the outfit. It should be noted that by laying the belt crosswise in the lip, the side of the plate may be used as a gage for squaring up the ends, thus materially assisting in producing a serviceable and efficient joint.

CLEVELAND HORIZONTAL BORING, MILLING AND DRILLING MACHINE

The horizontal boring, milling and drilling machine shown herewith is built by the Cleveland Machine Tool Works, Cleveland, O. As may be seen, it is of the type in which the boring head is vertically adjustable on a stationary column, while the work is mounted on a table provided with cross and longitudinal movements. The main features of this particular design are its simplicity, the provision of gear boxes for the feeds and speeds, and its convenience of operation.

In regard to the matter of ease of operation it will be seen at once that all the various handles required for controlling the movements of the machine are within easy reach from the operator's position. The machine is driven by the constant speed pulley shown, which is provided with a friction clutch operated by the vertical lever. From here the power is taken to a speed change mechanism operated by the right hand one of the two gear box handles. Six speeds are provided at this point. This number is doubled by back gears in the head, giving 12 spindle speeds in all, in geometrical progression, ranging from 10 to 140 revolutions per minute of the spindle. The gear ratio from the vertical driving-shaft to the spindle is 7 : 4, with a back gear ratio of 12 : 1 for the slower speeds. The back gears are thrown in or out by a conveniently mounted lever on the head. Another adjacent lever stops, starts and reverses the spindle.

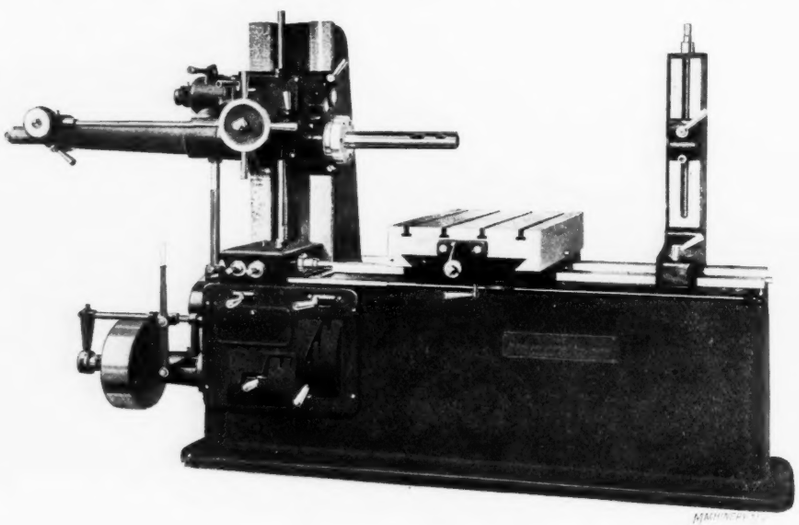
There are 16 feeds, applicable either to the vertical traverse of the head, the horizontal traverse of the work-table, or the longitudinal feeding of the boring bar. These vary in geometrical progression from 0.005 to 0.3 inch per revolution of the spindle. Eight of these are available for each position of the spindle back gear. Four changes are obtained by manipulating the handle of the right-hand gear box at the base of the machine, this number being doubled by the handle above it. All the feeds can be changed in direction by means of the reversing lever, and all the changes of feeds and speeds can be made without interference, while the machine is running.

The spindle is supported in solid taper bronze bearings with adjustments for wear. It has a face-plate to receive milling cutters, facing heads, etc., for heavy work. The fact that it can be stopped, started or reversed instantly makes the machine very convenient for facing, tap milling and similar operations. The spindle and back gear drive are located between the spindle bearings, bringing the power directly to the work with little strain to the mechanism. The spindle bar is 2½ inches in diameter, is provided with a No. 5 Morse taper hole and has a 22-inch traverse. It has a power feed in either direction, and can be securely clamped for face milling operations. The feed pilot wheel, by the shifting of the knob shown in its center, operates both the fine hand feed and the quick traverse for the boring bar.

The outboard support can be securely clamped to the bed and may be readily removed for overhanging work. It is aligned with the boring bar by means of scales and verniers reading to 0.001 inch. These scales also read directly to 1/64 and 1/100 inch, thus assisting in laying out bored holes to proper center distances. The box bed is very deep, with ribbing so designed as to make an expensive foundation unnecessary. Two chutes are provided for carrying away the chips. The platen has four ⅝-inch T-slots with a working surface of 20 by 36 inches, and a traverse of 24 inches. The platen and the carriage adjustments are made by means of micrometer dials.

The following additional dimensions will assist in giving an idea of the capacity of the machine. The maximum vertical adjustment of the head on the column is 20 inches, and the vernier adjustment is 18 inches. The greatest distance from the face-plate to the outboard support is 4 feet 6 inches. The floor space occupied over all is 11 feet 6 inches by 6 feet. The machine weighs about 6,000 pounds.

If required by the customer, special attachments for special work will be furnished with this machine. Among those for which provision is made are a revolving table, auxiliary table, special boring bars, and star feed facing head.



Cleveland Horizontal Boring, Milling and Drilling Machine

Fig. 1. Simple and Inexpensive Equipment for Autogenous Welding in Small Plants

AUTOGENOUS WELDING EQUIPMENT FOR LIGHT WORK

In the October, 1908, issue of MACHINERY, we described the equipment provided by the Autogenous Welding Equipment Co., 92 Hayden Ave., Springfield, Mass., for operations such as welding, etc., requiring very high heat, using for that purpose the oxy-acetylene flame. In addition to the apparatus there described, this firm has recently placed on the market an inexpensive outfit adapted to the general run of work met with in the ordinary garage or small machine shop. While the apparatus previously shown is particularly suitable for jobbing work and manufacturing, that shown in Fig. 1 is adapted to general repair work in smaller establishments.

The apparatus includes one torch equipment, having an assortment of tips, which makes it possible to carry on a large variety of work. A gas generator is not included. It

would not be feasible for the majority of small plants to install a generator, this being rendered doubly difficult by the insurance regulations, which require it to be located outside of the building; for this reason the gas for this apparatus is supplied in cylinders of 125 cubic feet capacity. This gives a sufficient supply for performing a large number of jobs, and a full cylinder will be shipped to the customer immediately on receipt of the bill of lading for the empty one. The gas itself is furnished at a lower cost than is possible even when supplied for lighting purposes. An oxygen cylinder is also supplied with the equipment.

This outfit makes it possible to repair such expensive parts as cast iron cylinders, aluminum crank and gear cases, malleable axle housings, etc. While the operations are somewhat out of the range of the experience of the ordinary machine operator, complete instructions are furnished which will insure success in the hands of reasonably intelligent workmen.

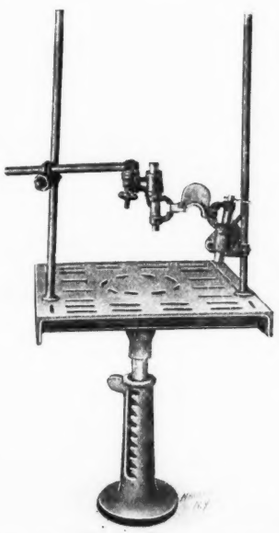


Fig. 2. Universal Table and Fixtures for Holding Parts for Autogenous Welding, Brazing, etc.

In Fig. 2 is shown a table which has been found especially adapted to the general line of work in small shops and garages. It has a substantial top, 30 inches square, with T-slots so arranged that the broken parts may be easily lined up and bolted into position. The table is carried on a ball and socket joint, so as to permit it to be tilted through a wide range of angles and fastened at that point. At any angular position the table can be revolved freely to bring the work to a position convenient for the operator. The pedestal is telescopic, so that the table can be raised and lowered as may be required. The edges are provided with flanges permitting the work to be clamped in a vertical position if desired. The top of the table is machined to permit accurate lining up of the work, and the underside is well ribbed, giving the necessary rigidity.

The universal clamping fixture for use in connection with this table, shown in place in the illustration, consists of a set of two universal vises, which can be held rigidly in any position by means of arms and clamps, so that broken parts of a wide range of shapes and sizes can be held together in the position required for welding or brazing. The provision of suitable clamping appliances is a matter of great importance in this work, as it has been found by experience that more time is consumed in setting up the work properly than in the actual welding or brazing, where suitable appliances are not provided.

ADDITIONS TO THE STARRETT LINE OF SMALL TOOLS

The L. S. Starrett Co., of Athol, Mass., has added a number of new instruments to its line of small tools. These additions are respectively, tool-makers' calipers and dividers, a universal bevel protractor with vernier scale, and sight attachments for the level.

The calipers and dividers, shown in Fig. 1, are particularly neat instruments, made from round stock with legs drawn down, giving the metal a hard and stiff quality. The fulcrum stud is hardened, the bows are of extra strength, the screw and nut are carefully fitted, and all the parts are finely finished. These tools are made with the solid nut only, in five sizes—2, 3, 4, 5 and 6-inch respectively.

An improvement in the well-known Starrett universal bevel protractor consists in the provision of a vernier scale which permits readings to be taken directly to as fine as 1/12 of a degree, or 5 minutes. Two verniers are used, so placed in relation to the graduated half of the circle as to make the protractor readable by vernier in any position. The protractor stock is 4 inches long, and is provided with either a 7- or a 12-inch blade, ½ inch wide. This is clamped by an eccentric stud against the edge of the disk. It may be slipped back and forth its full length and turned at any angle about its circle and firmly clamped where desired. The figures on the vernier are placed close to the lines, thus making it easy to read the tool when taking measurements. An attachment

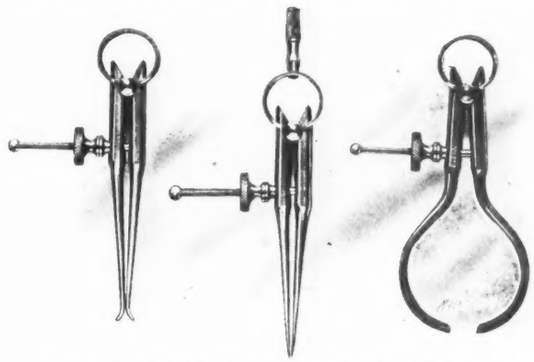


Fig. 1. A Neat Set of Outside and Inside Calipers, and Dividers for Toolmakers' Use

is provided for furnishing a reference edge at right angles to the regular blade. This, in connection with the beam of the protractor, will be found convenient in grinding short or long tapers to any angle or pitch.

The attachments shown in Fig. 2 are designed to be used in connection with the makers' iron levels. They easily slip on or off the top side of the instrument, and are held in place by set screws. They are provided with sight holes as shown, the one at the left having a cross wire which is accu-

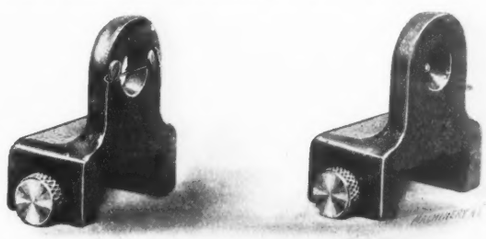


Fig. 2. Sighting Attachments for Use with Spirit Level

rately lined and set parallel with the level. This attachment will be found convenient, as it permits the use of the ordinary iron level for leveling a plot of ground from a fixed point at long range. They are made to fit the 6, 9, 12, 18 and 24-inch, No. 132 levels.

BENNETT HANDY GREASE CUP

The Bay State Stamping Co., of Worcester, Mass., has recently designed the grease cup shown herewith. It is particularly intended for automobile use, but should find a wide application wherever grease cups are used, particularly on high-speed machinery subject to jar or vibration.

A Simple Grease Cup

The cup itself is formed of sheet metal, with a hexagon the full diameter of the barrel, so that it may be screwed down close to the bearing and give a greater space for the grease without increasing the over-all height. The threaded cup is screwed down permanently, so that it will not jar off. It is provided with a thumb screw passing through the center, actuating a spring piston head, which binds on the inside of the cup to prevent it from turning. By screwing this down, the grease is forced into the bearing. The spring construction of this head makes a close joint, so that the grease, even if melted, is prevented from leaking out. This construction provides a neat, durable, and simply constructed cup for use on small or large bearings. It takes up little space, and may be quickly and easily operated.

NEW DESIGN OF PEERLESS MULTIPLE SPINDLE AUTOMATIC SCREW MACHINE

In the department of New Machinery and Tools of the December, 1908, issue of MACHINERY, we illustrated and described a multiple spindle automatic lathe, or screw machine, built by the Peerless Automatic Machine Co., of Cleveland, O. This firm has recently developed a variation of the design shown at that time, possessing features which fit it to a more general line of work. These changes relate principally to the provision of a constant speed drive with geared changes for the spindle and feed mechanisms, the use of a knee-type tool-holder, and the provision of a supplementary swinging tool-holder, applicable to either the third or fourth spindle positions.

As the above changes have been made without altering the general construction, the machine will not be described throughout. It needs merely to be said that it is a multiple spindle machine of the type in which the work spindles revolve, and are indexed from one tool position to another successively, the tools being fed by the longitudinal movement of the holder in which they are carried. Two independent cross-slides are provided. The threading mechanism is of the differential type, in which the tap or die is backed off by being run in the same direction as the spindle, but at a higher rate of speed. All the movements of the machine are controlled by the longitudinal feed drum shown beneath the tool-slide in Figs. 1 and 2, and by the various members keyed to the cam shaft at the rear of the machine in Fig. 2, this being geared with the longitudinal cam. The oil pump is connected by sprocket wheels and chain with the driving pulley, so that oil is always supplied to the cutting tools as long as the spindles are in motion.

The arrangement of the single pulley, constant speed drive is most plainly shown in Fig. 3. The high-speed driving pulley operates the entire mechanism of the machine. It may be connected directly with a clutched pulley on the line-shaft, or with tight and loose pulley counter-shaft if desired. It is connected through reducing gearing with the constant speed shaft at the same height with it on the left. Change gears, as shown, connect this shaft with the spindle driving shaft operating the stock spindles. The change gears provided give a wide range of speeds suitable for the different stock diameters and feeds. The cam mechanism is driven in one of two ways—either rapidly at constant speed from a direct connection with the constant speed pulley, or through change gearing at a slower speed. The former is used for the idle and changing stock feeding movements, and the latter for the feeding of the tool. The connection with the constant speed pulley, when the spindle head is being indexed, etc., insures that the machine shall always perform its idle movements at the maximum practicable speed, irrespective of the spindle speeds. The change from idle to operating feed is made by dogs, adjustably mounted on the circular plate at the end of the cam-shaft shown in Fig. 3.

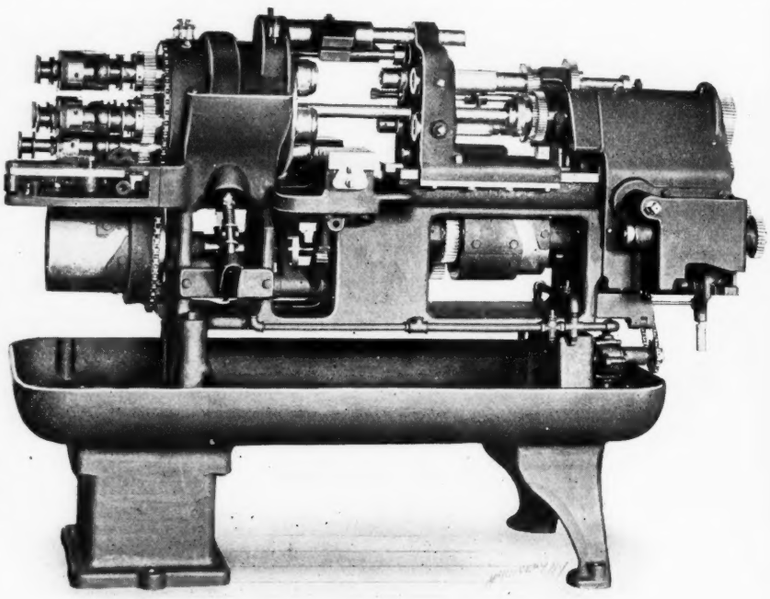


Fig. 1. Gear-driven Peerless Multiple Spindle Screw Machine

For the feeding movements the cam mechanism is driven from the spindle driving shaft through the quick change gear box shown at the right in Fig. 1. This gives five changes of feed. By changing about the two gears shown on shafts in horizontal alignment with each other at the left of Fig. 3, five more feeds are obtained. By using an extra set of similar gears furnished with the machine, ten more feeds may be

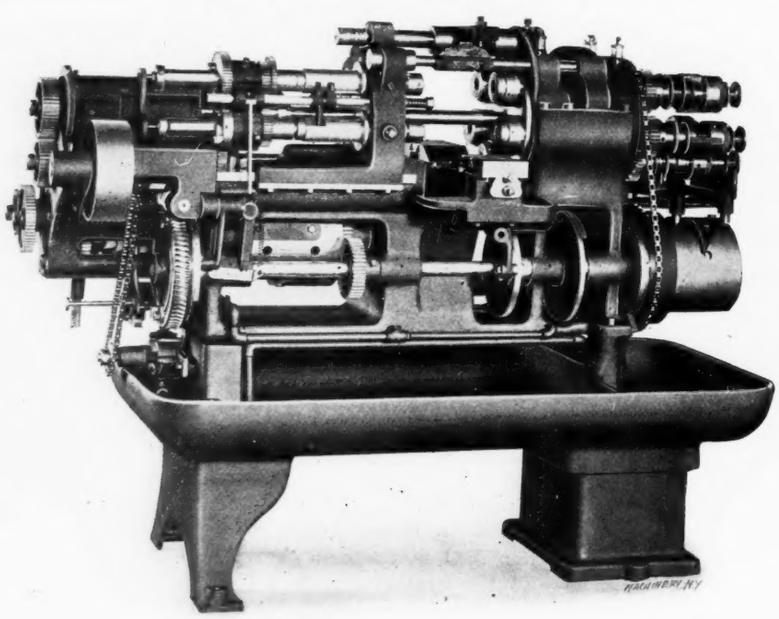


Fig. 2. Rear View of Machine, showing Oscillating Tool Holder

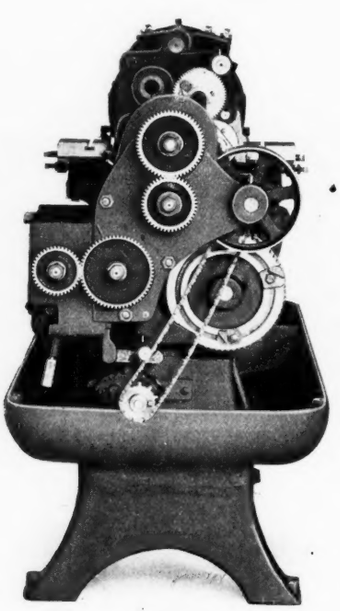


Fig. 3. End View, showing Speed and Feed Change Gears

obtained in the same manner, giving a total of 20 changes, ranging from 0.003 to 0.024 inch feed per revolution of tne spindle. These feeds always bear a definite relation to the spindle speed, since they are driven from the spindle driving shaft.

The cam mechanism can be instantly disengaged and locked into disengagement by pushing inward the knob shown below the feed box in Fig. 2. This may be done during either the active or the idle movements of the machine. The cams can thus be hand operated by means of a crank handle attached to the squared end of the shaft projecting from the feed box, shown in Fig. 1. To set the cam mechanism into action again the knob is pulled outward, thus starting the feed. It is impossible to start the fast feed when the tools are in their operating position, or to start the slow-feed when they are in their idle position, so that there is never any danger of disaster on that account.

The auxiliary tool-holder, seen best in Figs. 1 and 2, is journalled on a bar held in the spindle bearing cap, and sliding in a seat on the upper side of the longitudinal tool-slide. This operates, as previously mentioned, on either the third or fourth spindle position. It is oscillated into the work by the cam shown in Fig. 3, adjustably carried by a rod fastened to and moving with the longitudinal tool-slide. A spring returns the auxiliary holder to its normal position.

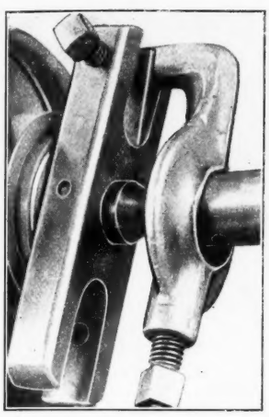


Fig. 1. Type of Dog Commonly Used

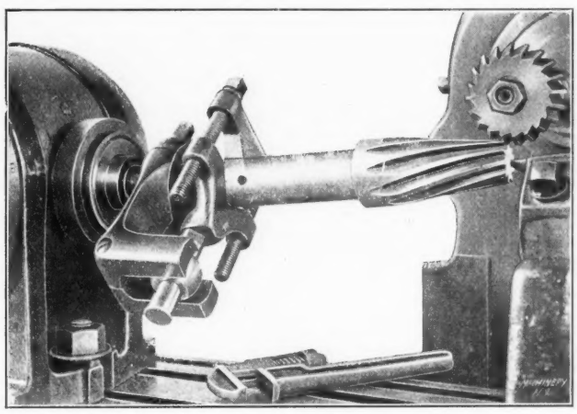


Fig. 2. A Dog which permits Indexing and Spiral Cutting on Taper Work

All the moving parts of this machine are guarded wherever necessary. These guards are shown removed in the engravings, to permit a more complete view of the mechanism.

HILL MILLING MACHINE DOG

The common lathe dog ordinarily used in the milling machine is very unsatisfactory for indexing work on taper milling, as every mechanic knows, when the taper is obtained by raising the tail-stock center. Under these conditions the tail of the dog slides in and out of the driver slot, so that it either develops lost motion, or clamps in the driver, springing the work and throwing a severe strain on the centers. It is quite common to use a shim as shown in Fig. 1 to take up the varying looseness between the point of the screw and the shifting tail of the dog. The liability of this shim to drop out under ordinary conditions, and the practical certainty of its doing so when milling taper spirals, makes the device an uncertain one at the very best.

In Fig. 2 is shown a special milling machine dog made by the M. B. Hill Mfg. Co. of Worcester, Mass., which obviates in a very satisfactory way the difficulties just described. As may be seen, the device consists of a driver, clamped to the nose of the dividing head spindle or to the live center, depending on the construction of the head, and provided with grooved jaws in which slides the ball shown. The tail of the dog passes through this ball, moving up and down in it as the angle of the work varies, the ball at the same time moving in or out as required. The ball and the tail of the dog are hardened, ground and lapped to a close fit. The grooved jaws of the driver are split and provided with an adjusting screw for maintaining the proper fit of the groove on the ball.

It will be seen that the set-screw in the driver used in Fig. 1, which causes all the difficulty in work of this kind, is dispensed with. After the dog is placed in position on the centers, no further attention is required. It is held rigidly in the driver, while still permitting movement in any direction as required by the work. Its action is automatic, so that unskilled labor may be employed in operations of the kind to which it is adapted.

Not only does this device give a positive drive for taper work, which is lacking under the old conditions, but it mitigates the indexing errors due to the sliding of the tapered tail of the dog in or out of the slot, when set up as shown in Fig. 1. This accuracy of indexing permits the milling of rectangular tapers by the simple raising and lowering of the head center, a feature which is peculiar to this make of dog and driver.

POSITIVE BLADE STOP FOR LANG TOOL-HOLDER

The tool-holder made by the G. R. Lang Co. of Meadville, Pa., illustrated in the department of New Machinery and Tools of last month's issue of MACHINERY, has been improved by the provision of a positive stop or abutment for preventing the blades from backing into the hole, even under the heaviest possible cuts. The change consists simply in drilling a row of pockets, which furnish successive seats for a commercial hardened steel ball. The ball is placed in that one of these pockets which agrees with the length of the blade in use. The blade is pushed back against it and is thus provided with a positive stop. In tests it has been found that a blade so held cannot be shifted from its position even when the clamp bolt is lost and the holder is placed in a vise with the weight of a heavy man on the handle. This device is now applied to all tool-holders of the style described, made by this company.

* * *

NEW MACHINERY AND TOOLS NOTES

CENTERING AND LAYING-OUT TOOL: Max Jaeger, 109 No. Terrace Ave., Mt. Vernon, N. Y. This device may be used on circular work for finding the center, and laying out the positions of holes and surfaces therefrom.

STEEL TOOL RACK: Davis Mfg. Co., Milwaukee, Wis. This piece of shop furniture is made entirely of steel. It is provided with two shelves, a drawer and a bin for waste, etc. A tool-chest can be conveniently mounted on the top.

SOCKET WRENCH: Frank Mossberg Co., Attleboro, Mass. This wrench is provided with a folding handle which permits storing the tool in a very small place. Removable sockets permit its use on a wide range of nuts and bolt-heads.

⅝-INCH RIVETING MACHINE: Harvey Hubbell, Inc., Bridgeport, Conn. This riveting machine is of the maker's well-known rotary type, similar in principle to his smaller size, but designed for use up to and including 7/16-inch diameter.

20-INCH ROUGHING LATHE: Schumacher & Boye, Cincinnati, O. This lathe is of simple and rigid construction, provided with a two-step cone for a 6-inch double belt and double back gears. The feeds are gear-driven through a quick change gear box of the Emmes type.

DOWN FEED ATTACHMENT FOR SHAPER: Queen City Machine Tool Co., Cincinnati, O. This attachment is operated by a worm-wheel and ratchet mechanism, controlled by dogs adjustably mounted in a slot in the holding-down gib, for the ram. The mechanism is very compact and simple.

FRICTION CLUTCH: Edgemont Machine Co., Dayton, O. This clutch is of the type in which a split rim is expanded by a lever movement against the inside of the pulley rim. An improved construction gives flexibility to the friction ring without decreasing its holding power.

PAYZANT BLOCK LETTERING PEN: Keuffel & Esser Co., Hoboken, N. J. This pen is made in a variety of sizes, any one of which gives a line of definite width, no matter in what direction the pen is moving. A reservoir is provided to permit the use of the pen for a long time without refilling.

COMBINATION DEPTH GAGE AND SQUARE: Wm. J. Gillard, 3617 Chicago Ave., Minneapolis, Minn. This tool consists of a pair of telescoping scales and a clamp, so arranged that the scales may be used either as a depth gage or as a square, set to any desired dimensions within the range of the tool.

HORIZONTAL SPRING TESTING MACHINE: Thomas Carlin's Sons Co., Pittsburg, Pa. This tool applies the pressure by means of a horizontal pneumatic cylinder mounted on a framework of convenient construction for handling the springs. It may be profitably used also as a bull-dozer for light work.

TURRET LATHE: Meriden Machine Co., Meriden, Conn. This turret lathe has a 20-inch swing, and is provided with friction head and back gears. The turret slide is adjustable vertically and longitudinally for centering the tool. An automatic chuck is provided, and an overhead brace is employed for stiffening the turret stud.

NO. 4 GEAR-DRIVEN PLAIN MILLER: Hendey Machine Co., Torrington, Conn. This milling machine is gear-driven, with a double back-gear connection. The feeds, as well, are positive and gear-driven. The mechanism is a modification of the well-known Norton gear box. Fifteen spindle speeds are obtained and twenty-one changes of feed.

GANG DRILL WITH TAPPING MECHANISM: Rockford Drilling Machine Co., Rockford, Ill. This gang drill is composed essentially of three of the maker's regular drill presses, provided with tapping attachments. A single belt drive is used for the three, and the frames are connected by stiff cross bracing. A special fast feed is provided for reaming.

ROTARY HOT SWAGING MACHINE: Langelier Mfg. Co., Providence, R. I. This tool is similar to the makers' well-known rotary cold swaging machine, with the addition of a pneumatic holding device for the work, and the provision of an air blast for blowing the scale away from the dies. An oil pump gives continuous lubrication to the working parts.

LEMLEY FRICTION CLUTCH: W. A. Jones Foundry & Machine Co., 800 Noble St., Chicago, Ill. This is a clutch of the type in which a radial flange is compressed between two rings of wood, the compression being obtained by means of a powerful toggle mechanism, easily operated. The adjustment is simple. The clutch is made in both the pulley and cut-off coupling styles.

HELICAL WIRE COILING MACHINE: F. B. Shuster Co., New Haven, Conn. This machine is of the three-roll type, adjustable to produce helical coils out of wire ⅛ to ⅜ inch in diameter, in coils of 4 to 30 inches in diameter, and in lengths up to 16 feet. The pipe mandrel by which the helix is supported revolves in such a way as to reduce the friction usually required for driving the coils.

RADIUS MILLING MACHINES: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. These machines are made in both vertical and horizontal styles, for milling radii up to 100 inches, and arcs up to 68 inches in length. While adapted to a general line of radius milling, they were originally developed for steam turbine work, on which they have been found very effective.

GANG PUNCH WITH SPACING TABLE: Long & Allstatter Co., Hamilton, O. This gang punch will use eight 13/16-inch punches and dies simultaneously. These may be spaced to any convenient lay-out, and each may be rendered individually operative and inoperative as required. The spacing table permits the longitudinal indexing of the work accurately to the dimensions given on the lay-out.

20-INCH DRILLING MACHINE WITH POSITIVE FEED AND DOUBLE SPINDLE ATTACHMENT: Mechanics Machine Co., Rockford, Ill. This drill press is provided with a double spindle attachment, positive feed and built-in tapping attachment. In the double attachment the two spindles may be adjusted through a wide range of center distances, being held in a circular slot and driven by a gear mounted in the end of the main spindle.

IMPROVED DRAFTING MACHINE: Universal Drafting Machine Co., Cleveland, O. This well-known instrument has been redesigned in its details, while retaining the same principles employed in the older models. The principal change relates to the provision of ball bearing joints. A number of improvements have also been made in the supporting mechanism, adapting the tool for use on boards of the largest size, under a wide range of conditions.

HIGH-DUTY FACE MILL: Cincinnati Milling Machine Co., Cincinnati, Ohio. This face mill has a body and a backing ring of machine steel, carrying cutters made of ½ by 1¼-inch stock, fastened by a flattened taper pin in front of the cutting edge. The height of the latter is adjusted by small screws at the back of the head. This cutter has been found by the makers to produce results on face milling work hitherto unattainable for tools of the same size.

MULTIPLE STARTERS FOR LARGE DIRECT CURRENT MOTORS: Westinghouse Co.'s Pub. Dept., Pittsburg, Pa. These starters are much more effective and safe for large motors than those of the rheostat type used for the smaller sizes. The motor is started by the closing of series of switches, interlocked so as to prevent their closure except in the proper order. All the precautions necessary have been taken to prevent danger from overloads under all possible conditions.

MACHINE FOR FINISH GRINDING THE TEETH OF GEARS: Gear Grinding Machine Co., Detroit, Mich. This machine employs a formed emery wheel for shaping the teeth of gears. While especially devised for finishing gears after hardening, it has been found profitable to use it in place of a finish cutter on soft gears, and also for giving the proper shape to cast gear teeth. An automatic truing device is provided which keeps the wheel constantly formed to the correct outline.

SIX-FOOT RADIAL DRILLING MACHINE: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. This tool resembles the makers' older design in its general lines, but has been greatly strengthened and stiffened throughout, presenting an unusually powerful appearance. The machine has been re-designed from data collected in the past two years from a number of prominent shops. It is designed to produce results superior to anything hitherto obtained in the way of output.

ELAPSED TIME RECORDER: International Time Recording Co., Flat Iron Building, New York City. This instrument is of remarkably ingenious construction, being employed for stamping on a ticket the date and hour at the beginning of a job, and at its completion, stamping the time of completion and the elapsed time—in other words, the time it has taken to do the work. It will do this over a period of several days, taking into account only the hours when the shop has been running and leaving half-holidays and Sundays out of consideration. Its use should thus greatly facilitate cost-keeping calculations.

FOURTEEN-INCH ENGINE LATHE WITH GEAR BOX: W. P. Davis Machine Co., Rochester, N. Y. This lathe is equipped with a quick-change gear box, giving 30 possible changes ranging from 3 to 30 threads per inch. Special or fractional threads may be cut by changing gears at the end. The tail-stock is offset to allow the compound rest to be swung parallel with the bed, and it is provided with a set-over for turning tapers. The carriage has a deep bridge, and the cross-feed screw collar is graduated to read to thousandths of an inch. With a six-foot bed the lathe swings 37 inches between centers and 9½ inches over the carriage. The cone diameters range from 4⅛ to 9 inches, and the back gear ratio is 10 to 1. The net weight of the lathe is 1,600 pounds.

LIQUID SEALED ANNEALING BOX: Raymond H. Kinnear, 2 Rector St., New York City. This annealing box is of unique construction, in that it is rendered air-tight without requiring a luting of clay or similar material. The form of the box and its cover provide a trough, which is sealed with molten lead, effectually preventing the entrance of the air and the consequent oxidization of the work. When the box has cooled, the cover is readily withdrawn. The outward passage of gas generated in the interior is not restrained by this construction. The lead remains in the groove and is always ready for subsequent heats. A small quantity of graphite floating on the top prevents its oxidization.

ACCELERATING CUT PLANER: Powell Tool Co., Worcester, Mass. This tool of which mention was made in the article entitled "Improvements in High-Speed Steel," in the April, 1909, issue of MACHINERY, employs the novel principle of starting the work against the tool at about the ordinary rate of speed, and then accelerating it to a cutting speed much higher than ordinarily found possible. The economy from this operation lies in the fact that the limiting cutting speed on a planer is usually determined by the impact of the tool on the stock at the beginning of the cut, consequently the rate may be increased after this dangerous impact has passed. While there has been a recent tendency to increase the reverse of the planer table, it is evident that this increase of the rate on the cutting stroke means much more in the way of increase of output.

* * *

A POPULAR RESOLUTION

At the recent convention of the National Machine Tool Builders' Association, held in Milwaukee, some wag brought down the house by having Secretary Montanus read the following resolution:

WHEREAS: The designs of machine tools are rapidly changing and improving, and,

WHEREAS: The manufacturer who uses tools of obsolete design is doing himself and his employes a very great wrong, and,

WHEREAS: There does not seem to be any method so far developed to convince the user of obsolete machine tools of the wrong he is doing himself and the community; therefore, be it

RESOLVED: That this association, through its members, urge upon the legislatures of the various States to pass laws making the use of a machine tool for a period longer than ten years a crime punishable with suitable penalties.

A. R. M. M. AND M. C. B. ASSOCIATIONS CONVENTIONS

The forty-second annual convention of the American Railway Master Mechanics' and the forty-third annual convention of the Master Car Builders' associations were held at Atlantic City, N. J., June 16-23 inclusive. Following the custom of alternating the conventions in the matter of priority, the Master Mechanics' Association convention was held June 16, 17 and 18, and the Master Car Builders' Association convention followed on June 21, 22, and 23. Simultaneously with these conventions was the exhibition of railway supplies and apparatus, machine tools, etc., under the auspices of the Railway Supply Manufacturers' Association on Young's New Pier. This is one of the most important exhibits annually held in the United States, in point of capital represented, comparing favorably with many national expositions that are widely advertised.

The general technical program of the Master Mechanics' Association was made up as usual consisting largely of reports made by committees interspersed with individual papers, as follows:

June 16.—Discussion of reports on: "Mechanical Stokers"; "Revision of Standards"; "Motor Cars."

Topical discussion: 1. "Is the additional cost of flexible stay-bolts justifiable?" opened by H. D. Brown, Erie R. R. 2. "Is the usual front row of crown bolts in a locomotive boiler beneficial or otherwise?" opened by C. A. Seley, Rock Island Lines.

Discussion of individual paper on "Bank vs. Level Firing," by E. D. Nelson, Pennsylvania R. R.

June 17.—Discussion of reports on: "Castle Nuts"; "Safety Valve"; "Superheaters."

Discussion of individual paper, "Locomotive Performance under Saturated and Superheated Steam," by Prof. W. F. M. Goss, University of Illinois.

Topical discussion: 1. "Vanadium steel—Have the advantages claimed and shown in laboratory tests been substantiated in practice, particularly as regards the strengthening of locomotive parts?" opened by W. C. A. Henry. 2. "Are bypass valves necessary on piston valve locomotives?" opened by H. T. Bentley, Chicago & Northwestern Ry.

Discussion of reports on: "Widening Gages on Curves"; "Steel Tires."

June 18.—Discussion of reports on: "Tender Trucks"; "Fuel Economies"; "Lubricating Material Economies."

Individual paper: "The Transfer of Heat," by Prof. Charles E. Lucke, Columbia University.

Topical discussion: 1. "Is previous railway experience of advantage to locomotive firemen? If so, how may this be handled in a practical manner?" opened by D. R. MacBain, N. Y. C. R. R. 2. "Brick arches and water tubes, their value and influence on fuel economy," opened by J. F. Walsh, Chesapeake & Ohio Ry.

The meeting was conducted by President H. H. Vaughan, assistant to the vice-president of the Canadian Pacific Ry.

The following officers were elected:

President, G. W. Wildin, N. Y. N. H. & H. R. R.
First vice-president, C. E. Fuller, Union Pacific Ry.
Second vice-president, H. T. Bentley, C. & N. W. Ry.
Third vice-president, D. F. Crawford, Pennsylvania Lines.
Treasurer, Angus Sinclair, *Railway and Locomotive Engineering.*
Executive Committee: C. A. Seley, C., R. I. & P. (two years); D. R. MacBain, N. Y. C. & H. R. R. R. (two years); F. M. Whyte, N. Y. C. & H. R. R. R. (one year).

The program of the Master Car Builders' Association convention was made up in the usual manner consisting of topical discussions and individual papers as follows:

June 21.—Discussion of reports on: "Revision of Standards and Recommended Practice."

Topical discussion: 1. "Wheel defects—Is a brake burn due to prolonged brake application properly an owner's defect? How is it to be distinguished from the defect known as shelled out?" opened by H. D. Taylor, P. & R. Ry. 2. "Application of suitable lugs to steel or steel underframe cars for jacking up car bodies, and application of suitable push pole pockets to avoid damage to cars," opened by Thomas Paxton, El Paso & S. W. Ry.

Discussion of reports on: Train Brake and Signal Equipment"; "Brake Shoe Tests."

June 22.—Discussion of reports: "Tests of M. C. B. Coupler"; "Revision of Rules for Loading Long Materials"; "Rules of Interchange," including report of arbitration committee on "Revision of Freight and Passenger Car Rules"; also reports of committees on "Freight Car Repair Bills and Air-Brake Hose"; "Cast Iron Wheels"; "Splicing Sills"; "Tank Cars"; "Safety Appliances"; "Side Bearings and Center Plates."

June 23—Discussion of reports: "Freight Car Trucks"; "Painting Steel Cars"; "Side and End Door Fixtures"; "Train Pipe and Connections for Steam Heat"; "Classes of Cars"; "Salt Water Drippings from Refrigerator Cars"; "Revision of Constitution and By-Laws"; "Subjects."

Topical discussions: 1. "Wheel mounting pressures for various sizes of cast iron and steel wheels," opened by W. T. Gorrell, P. & R. Ry. 2. "Cleaning triple valves and brake cylinders on freight cars to meet Interstate Commerce Commission requirements," opened by T. L. Burton, C. R. R. of N. J.

The meeting was conducted by President R. F. McKenna, master car builder of the Delaware, Lackawanna and Western R. R. The following officers were elected:

President, F. H. Clark, C. B. & Q. R. R.
First vice-president, T. H. Curtis, L. & N. R. R.
Second vice-president, LeGrand Parish, L. S. & M. S. Ry.
Third vice-president, A. Stewart, Southern Ry.
Treasurer, John Kirby, Adrian, Mich.
Executive Committee: D. F. Crawford, Pennsylvania Lines; F. W. Brazier, N. Y. C. & H. R. R. R.; C. A. Schroyer, C. & N. W. Ry.; J. D. Harris, B. & O. R. R.; C. E. Fuller, U. P. R R. (hold over); H. D. Taylor, P. & R. Ry.

The Mechanical Exhibits

The exhibit of machine and railway appliances comprised a seemingly larger proportion of machine tools and accessories for the machine shop than any previous exhibit, there being about fifty concerns represented out of a total of 228 exhibitors, who manufacture machine tools, machinists' hand tools and other accessories that are used in metal working. The exhibits were arranged on Young's New Pier in the same general order as in past years. Machinery Hall on the east side of the pier near the entrance was mostly filled with machine tools and would have been entirely filled had the management given the concerns space in this section where they properly belonged. A passenger car vestibule, steel car, and a few other examples of rolling stock equipment were clearly out of place and should have been grouped in another part of the exhibit with related exhibits.

The matter of proper segregation of exhibits is important. In the business districts of large cities, the tendency is for competitive lines to gather in the same localities, and the same idea should be followed in managing exhibits of machinery and tools. Lathes, planers, shapers, grinding machines, boring, drilling and milling machines, upright and radial drills, boring mills, automatic screw machines, nut tappers, plain grinding, cylinder boring machines, twist and flat drills, reamers, and all metal-working tools necessary for locomotive building and repair work should be grouped in one section so far as possible. Blacksmith shop tools and boiler shop tools should form a section intermediate with the purely machine tools section and the sections in which the rolling stock equipment and appliances are shown. In this section should be shown flue welders, flue rattlers, furnaces, riveters, pneumatic tools, etc.

Many of the machine tools were in operation and when all were working together the scene was animated, indeed. The tests of the power of radial drills using flat twisted high speed drills, attracted a great deal of attention, and some startling results were obtained in heavy high speed drilling. High speed shapers also received their share of attention and many remarked that the modern shaper is a very healthy competitor of the planer. The turning, boring, grinding, and threading operations did not lack for attention, but whether it was bestowed by railway officials intelligently or not, future sales only will show.

Exhibitors of Metal-working Machines and Accessories

Ajax Mfg. Co., Cleveland, Ohio. Improved bolt head upsetting and forging machine; high speed bulldozer and bending machine; reclaiming rolls for re-rolling scrap; hot sawing and burring machine.

American Blower Co., Detroit, Mich. Blowers for forges and furnaces; heating and ventilating apparatus, mechanical draft apparatus; vertical enclosed, self-oiling steam engines; Sirocco blowers.

American Specialty Co., Chicago, Ill. "Use-Em-Up" drill sockets and sleeves; Collis high-speed flat and flat twisted drills, universal adjustable blade reamers.

American Tool Works Co., Cincinnati, Ohio. Engine lathe, 24-inch by 12 foot, driven by Northern direct-connected motor;

multi-speed planer 36 inches x 36 inches by 10 feet, driven by direct-connected Westinghouse motor; 25-inch crank shaper with speed box, driven by direct-connected General Electric motor; 5-foot triple-geared high speed plain radial drill, driven by direct-connected Crocker-Wheeler motor; 2-foot high speed ball bearing radial drill with tapping attachment, driven by direct-connected Lincoln motor; Willey motor-driven water tool grinder with 2-inch x 16-inch wheel.

American Vanadium Co., Pittsburg, Pa. Vanadium ores, alloys, and steels, both wrought and cast, comprising saws, tires, axles, crank-shafts, locomotive frames, etc.

Armstrong-Blum Mfg. Co., Chicago, Ill. Power hack saw machine, portable grinder for lathes and planers, lever punch and shear.

Armstrong Bros. Tool Co., Chicago, Ill. Tool holders, ratchet drills, vises, C-clamps, knurling tools and other machine shop specialties.

Besly & Co., Charles H., Chicago, Ill. Besly spiral disk grinder, spiral circles, taps, oil and babbitt.

Boker & Co., Hermann, New York. "Novo Superior" steel and other high-speed steels, including "Intra" steel.

Brown & Sharpe Mfg. Co., Providence, R. I. Plain milling machine, vertical milling machine, and attachments for milling machines. Machines in operation.

Bullard Machine Tool Co., Bridgeport, Conn. Vertical turret lathe, in operation.

Carborundum Co., Niagara Falls, New York. Carborundum wheels, sharpening stones, rubbing bricks, carborundum paper and cloth and other abrasive products.

Celfor Tool Co., Chicago, Ill. High speed drills, reamers, counter-sinks, three-lipped drills, chucks, etc. These drills were in use on several drilling machines in the exhibit.

Chicago Penumatic Tool Co., Chicago, Ill. Air compressor.

Chisholm & Moore Mfg. Co., Cleveland, Ohio. Differential chain hoists in various sizes, including a 30-ton hoist.

Cincinnati-Bickford Tool Co., Cincinnati, Ohio. High speed 24-inch upright drill; high speed 20-inch upright drill; 5-foot high speed radial drill. Radial drill in operation.

Cincinnati Planer Co., Cincinnati, Ohio. Forge planer 37 inches x 37 inches x 8 feet with four heads and variable speed motor drive, in operation.

Cleveland Twist Drill Co., Cleveland, Ohio. Twist drills, taps, reamers, sockets, etc.

Coe Brass Mfg. Co., Ansonia, Conn. Extruded brass in various cross sections, used in the manufacture of locks, pinions, ratchets, gears, etc.

Cooper-Hewitt Electric Co., New York. Cooper-Hewitt mercury vapor electric lamp for shop lighting.

Davis-Bournonville Co., New York. Oxy-acetylene welding and cutting plant comprising torches, generators, and compressors. Demonstration of process.

Davis Expansion Boring Tool Co., St. Louis, Mo. Expansion boring tools, lathe tools, planer tools, etc.

Dudgeon, Richard, New York. Hydraulic jacks, comprising car inspector's railway, plain, base, claw, independent claw, horizontal and traversing jacks; electrical power pump, and several types of hand-operated pressure pumps.

Foster, Walter H., New York. Bolt turning machine, Lassiter stay-bolt threading and reducing machines, stay-bolt hole squaring machine; Potter & Johnston automatic machines; Lassiter bolt drilling machine, stay-bolt nipper, automatic nut tapper.

Goldschmidt-Thermit Co., New York. Exhibit of thermit-welded locomotive frames, driving wheels, connecting rods; and fire brick molds shaped to fit various locomotive parts used in thermit welding.

Gould & Eberhardt, Newark, N. J. 24-inch high duty shaper, driven by a direct-connected Northern variable speed motor. Machine in operation.

Greene-Tweed & Co., New York. "Favorite" reversible ratchet wrench and other specialties.

Hill, Clarke & Co., Inc., Boston, Mass. 5-foot triple geared high speed radial drill; Milwaukee plain milling machine; Milwaukee full universal milling machine with various attachments; Universal horizontal boring machine. Milling machines in operation.

Hammett, H. G., Troy, New York. Radius grinder for locomotive links, and other specialties.

Harrington, Edwin, Son & Co., Inc., Philadelphia, Pa. Geared and differential hoists, and I-beam trolley.

Keystone Drop Forging Works, Chester, Pa. Drop forgings for locomotive and car work.

Landis Tool Co., Waynesboro, Pa. Plain and universal grinders.

Landis Machine Co., Waynesboro, Pa. Motor-driven bolt and pipe threading machines, demonstrating high speed threading. Machine in operation.

Linde Air Products Co., Buffalo, New York. Oxy-acetylene welding and oxy-coal gas cutting apparatus.

Link-Belt Co., Philadelphia, Pa. Renold machine driving chains.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. Engine lathe, 24-inch x 12 foot patent head, motor-driven; engine lathe 18-inch x 8-foot head, motor-driven. Machine in operation.

Manning, Maxwell & Moore, New York. Lathe, shaper, drills, inspirators, valves, and other specialties.

National-Acme Mfg. Co., Cleveland, Ohio. Automatic multiple spindle screw machine in operation.

Newton Machine Tool Works, Inc., Philadelphia, Pa. High duty radial drilling machine; cold saw cutting off machines; rapid production bolt threading machines.

Niles-Bement-Pond Co., New York. Pratt & Whitney toolroom lathe, tire gages, coupler gages, tire tapes, Pond rigid turret lathe, rapid action tool clamp for Niles driving wheel lathe, etc.

Norton Co., Worcester, Mass. Alundum grinding wheels.

Norton Grinding Co., Worcester, Mass. Norton gap grinding machine for locomotive work and other specialties. Machine in operation.

Queen City Machine Tool Co., Cincinnati, Ohio. 24-inch motor-driven shaper with gear-box driven by direct-connected Westinghouse motor. Machine in operation.

Revolute Machine Co., New York. Continuous electric blueprinting machine. Machine in operation.

Royersford Foundry & Machine Co., Royersford, Pa. Punching and shearing machines.

Russell, Birdsall & Ward Bolt & Nut Co., Portchester, New York. Finished and semi-finished castellated nuts, hexagon nuts, finished case-hardened nuts, etc.

Ryerson, Joseph T., & Son, Chicago, Ill. Rotary bevel shear, high speed friction saw, portable automatic key-seating machine, crank pin truing machine, flue welding machine, internal combustion riveter, etc. Riveter in operation.

Sellers & Co., William, Philadelphia, Pa. Line shaft hanger with cast iron boxes; photographs of new car wheel lathe, locomotive injectors, etc.

Standard Tool Co., Cleveland, Ohio. Twist drills, reamers, milling cutters, taps, and chucks.

Stoever Foundry & Machine Co., New York. Motor-driven automatic pipe-bending machine, in operation; motor-driven pipe-threading and cutting-off machine, in operation.

Tindel-Morris Co., Eddystone, Pa. High-duty cold sawing machine and inserted tooth high-speed steel saw blades.

Underwood & Co., H. B., Philadelphia, Pa. Portable cylinder boring bar; portable crank-pin turning machine, vertical boring machine for small gas engine cylinders, etc.

Watson-Stillman Co., New York. Hydraulic jacks, car wheel and crank pin presses, hydraulic rail benders and jacks, and turbine pumps.

Western Tool & Mfg. Co., Springfield, Ohio. Lathe and planer tool holders, expanding mandrels, etc.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Electric motors and other electrical apparatus.

Westinghouse Air Brake Co., Pittsburg, Pa. Cross-compound air pump, 8½ inches in section, driven by duplicate pump.

Yale & Towne Mfg. Co., New York. Electric hoists, chain blocks, I-beam trolleys and other specialties.

* * *

PERSONAL

C. E. Chambers has been appointed general master mechanic of the Central Railroad of New Jersey.

C. L. Cook, formerly of the Fairmont Coal Co., has been appointed chief engineer of the Fairmont Mining Machine Co., Fairmont, West Virginia.

Edward S. Pomeroy has been promoted from the position of foreman to master mechanic at the Smith & Wesson, Inc., revolver manufacturers, Springfield, Mass.

Harold Wesson has been appointed assistant superintendent at the Smith & Wesson, Inc., revolver manufacturers, Springfield, Mass.

Richard B. Cavanagh has entered the firm of Macdonald & Macdonald, patent lawyers, 50 Church St., New York, and the firm name hereafter will be Macdonald, Macdonald & Cavanagh.

H. R. Swartley, Jr., who has been the New York manager for the Electric Service Supply Co., Philadelphia, Pa., has taken charge of the Chicago office of the Variable Speed Clutch Co., of Milwaukee, Wis.

E. W. McKeen, for many years connected with the mechanical department of the Union Twist Drill Co., Athol, Mass., has been appointed manager of the company's New York store at 54 Warren St.

H. F. Frohman, general manager of the S. Obermayer Co., Cincinnati, Ohio, read a paper at the May meeting of the American Foundrymen's Association of Cincinnati, entitled "Standardizing Foundry Facings."

Harold A. Richmond, president of the American Emery Wheel Works, Providence, R. I., sailed for Europe June 17 on the *Friedrich der Grosse*. Mr. Richmond will visit the company's agencies in Berlin, Vienna, Paris, and Copenhagen.

F. W. Jackson, who has been connected with the engineering and sales department of the Harrisburg Foundry & Machine Works, Harrisburg, Pa., for a number of years, has been appointed district manager of the company for the Baltimore district with headquarters at 1415 Continental Trust Building.

Curtis Dougherty, formerly superintendent of the Springfield division of the Illinois Central Railroad, has been promoted to the position of superintendent of the Queen & Crescent Route and Alabama Great Southern R. R., with headquarters in Cincinnati, Ohio. Mr. Dougherty left the Illinois Central R. R. February 1, 1907, to go to the Queen & Crescent Route as assistant general engineer to Mr. H. E. Warrington, who has just resigned.

W. A. Hopkins, who has had charge of the electric construction work of the Wabash Railroad, and who was the real organizer of the electrical department, has resigned, and is now in charge of the southwestern branch of the New York Safety Car Heating & Lighting Co., covering territory extending from St. Louis to the Gulf of Mexico and west to the Pacific coast including Mexico, and as far north along the coast as Washington. The company now employing Mr. Hopkins has for a number of years had exclusive control of the Pintsch lighting system, but now will push the electric lighting system of trains also.

* * *

OBITUARIES

Benjamin F. Jones, for forty-two years the timekeeper for the Collins Co., Collinsville, Conn., died May 14, aged seventy years.

John W. Brawn, of Brawn & Sellers, Holyoke, Mass., manufacturers of wire cloth, Fourdinier and dandy rolls, died at his home in that city June 3, aged sixty-nine.

George W. Hall, foreman of the polishing room in Smith & Wesson, pistol manufacturers, Springfield, Mass., died May 29, aged fifty-one years. Mr. Hall was treasurer of the factory relief association.

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COMING EVENTS

July 8-10.—Massachusetts State Convention of the National Association of Stationary Engineers at Springfield, Mass. Exhibit of steam specialties and engineers' supplies in Graves Hall.

July 10-17.—Winnipeg (Manitoba) Industrial Exhibition from July 10 to 17. A. W. Bell, manager and secretary, Winnipeg, Manitoba.

August 9-14.—Seventeenth National Irrigation Congress, Spokane, Wash., for the consideration of an action on irrigation, drainage, forestry, good roads, deep waterways, and home building. Arthur Hooper, secretary, Board of Control, Spokane, Wash.

September 25-October 9.—Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the *Tribune* building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett, secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

October 4-8.—Annual conventions of the American Street and Interurban Railway Association, American Street and Interurban Railway Accountants' Association, American Street and Interurban Railway Engineering Association, American Street and Interurban Railway Claim Agents' Association, American Street and Interurban Railway Transportation and Traffic Association, American Street and Interurban Railway Manufacturers' Association, at Denver, Col. Bernard V. Swenson, secretary and treasurer, 29 West 39th St., New York.

SOCIETIES AND COLLEGES

Proceedings of the Twenty-eighth Annual Convention of the American Water Works Association Held at Washington, D. C., May 11-16, 1908. 800 pages, 6 x 9 inches. Published by the secretary, J. M. Diven, 14 George St., Charleston, S. C.

Armour Institute of Technology, Chicago, Ill. Bulletin No. 4 on the summer session which comprises courses in electrical engineering, chemical engineering, civil engineering, practical shop work, physics, mathematics, mechanics of engineering and drawing. Address for further information Dean of Engineering Studies, Armour Institute of Technology, Chicago.

Museum of Safety and Sanitation, 29 West 39th St., New York, announces the election of Arthur Williams to the board of trustees. Mr. Williams is the general inspector of the New York Edison Company and a member of the American Institute of Electrical Engineers. In 1907 he was decorated by the French Government. He is a member of the American section of the International Housing Congress and was a member of the Eighth International Congress of Social Insurances at Rome, 1908. Mr. Williams will serve on the lecture committee of the museum.

NEW BOOKS AND PAMPHLETS

On the Rate of Formation of Monoxide in Gas Producers. By J. K. Clement. 47 pages, 6 x 9 inches. Published by the University of Illinois Experiment Station, Urbana, Ill., for free distribution.

Engine Lathe Work. By Fred H. Colvin. 180 pages, 4½ x 7 inches, 127 illustrations. Published by the Hill Publishing Co., New York. Price $1.

The work treats of the engine lathe, circular lathe work, driving the work, tools for turning, face-plate work, chucks and chucking, boring tools, taper turning, thread turning, test indicators, care of lathes, etc. It is partly made up of elementary articles published in the monthly edition of the *American Machinist*. It will be found generally useful by apprentices, students and trade schools and others desiring to obtain elementary knowledge of the construction, use and operation of the engine lathe.

Westinghouse E-T Air Brake Construction Pocket Book. By W. W. Wood. 242 pages, 5 x 7 inches, illustrated. Published by Norman W. Henley & Son, New York. Price $2.

This instruction pocket book on the Westinghouse E-T air brake equipment differs from other works on the air brake, in that it is not of the catechism form, which has been the popular method of explaining air brake apparatus and other apparatus used in railway and stationary engineering. The new E-T equipment is described in detail. In this equipment the entire apparatus, including the engine and tender brake, has been reconstructed, and although the principle of the common triple valve has been retained, the general construction of the new equipment is so different from the older form that railway men must study its construction in order to understand its operation and action. The book is illustrated with numerous colored diagrams showing the pipes, cylinders, reservoirs, etc., the pressures in the various parts of the apparatus being indicated in colors so as to make the study of the apparatus convenient and easy.

Gas Engine Theory and Design. By H. C. Mehrtens. 256 pages, 5 x 8 inches, illustrated. Published by John Wiley & Sons, New York. Price $2.50.

The increase in importance and general interest in the gas engine is to some extent indicated by the number of new books that have been published in the last few years. The book in review has been prepared for students, draftsmen, engineers and men who operate gas engines, and is based on the author's instruction work at the Michigan Agricultural College. It treats of the general principle of operation, heat, thermodynamics, combustion, fuel, laws of gases, gas engine efficiency, explosive mixtures, mixing valves and carbureters, governing, ignition, cooling, exhaust, selection of type, determination of the principal dimensions, forces acting in the gas engine, design and dimensions of parts, gas engine manipulation, testing, designs. Tables are given on the physical properties of materials, petroleum distillates, properties of fuel gases, volumes and specific heats of gases, efficiencies at different altitudes, strength of materials, heat and power units, volume, pressure and temperature curves. The work has the appearance of being a practical and carefully prepared book that will appeal more to the student, draftsman and engineer than to the general run of men operating gas engines. We would not recommend it to the latter class unless they are interested in the problems concerning design and the thermodynamics of gas engines.

Calculation of Change Wheels for Screw Cutting Lathes. By D. De Vries. 83 pages, 5½ x 8½ inches. Published by Spon & Chamberlain, New York. Price $1.50.

In this work the author has handled the problem of change gearing of lathes in a very ambitious manner, but one discouraging to machinists who would buy a work of this character to obtain simple directions for gearing engine lathes. For a designer of machine tools who wishes to study the method for calculating approximate fractions at length he will find this part carried out in great detail. The book is divided into three chapters. The first describes the change mechanism of the engine lathe; the second and longest chapter is divided into heads, as follows: System; what change wheels are to be found on a lathe; the cutting of metric threads with a metric lead screw; the cutting of English threads with a metric lead screw; the cutting of English threads with an English lead screw; the cutting of metric threads with an English lead screw; the wheel with 127 teeth; method of calculating approximate fractions; the proof of the sum; fixing up the wheels; thread cutting with double compound threads; the cutting of left-hand threads. In the third chapter the forms of thread sections, types of threads, screw cutting tools, etc., are discussed. We believe that the book would be better appreciated by the mass of machinists if the section on the method of calculating approximate fractions and finding the approximate fraction were simplified and made much shorter.

CATALOGUES AND CIRCULARS

American Blower Co., Detroit, Mich. Catalogue of Sirocco fans.

Skinner Chuck Co., New Britain, Conn. Pamphlet illustrating Skinner chucks.

Ball & Wood Co., Elizabethport, N. J. Catalogue of Rateau-Smoot low-pressure turbines and generators.

Emerson Electric Mfg. Co., St. Louis, Mo. Bulletin No. 3908 on factory sewing machine electric motors.

Waltham Machine Works, Waltham, Mass. Leaflet illustrating escape wheel cutting machines for watch work.

Linde Air Products Co., Buffalo, N. Y. Descriptive pamphlet of "Pyrokopt" apparatus for cutting metals.

Phillips Pressed Steel Pulley Works, Philadelphia, Pa. Blotter advertising Phillips pressed steel pulleys.

General Electric Co., Schenectady, N. Y. Bulletin No. 4662 of Thompson recording watt meters for switchboard service.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Small catalogue of Westinghouse electric motors for the office, store and shop.

Jones & Lamson Machine Co., Springfield, Vt. Pamphlet containing detailed description of chip breaking turner for the flat turret lathe.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 114, superseding Bulletin No. 77 on coupled type alternating current generators.

H. G. Hammett, Troy, N. Y. Leaflet illustrating radius grinder for locomotive links and link blocks. The machine can also be converted into a surface grinder.

S. Obermayer & Co., Cincinnati, Ohio. Pamphlet advertising Obermayer foundry products and containing a guide to points of interest in and adjoining Cincinnati.

Tindel-Morris Co., Eddystone, Pa. Bulletins Nos. 1, 2, 4 and 5 of Tindel high-duty inserted tooth cold saw blades, crank-shaft lathes and crank-shaft grinding lathes.

W. S. Rockwell Co., 50 Church St., New York. Pamphlet illustrating Rockwell melting furnace for copper, brass, bronze, aluminum, silver, gold, iron, steel, etc.

Electric Welding Products Co., Cleveland, Ohio. Booklet illustrating electrically welded gas engine valve stems and other welded products largely used in the manufacture of automobiles.

Warner & Swasey Co., Cleveland, Ohio. Pamphlet illustrating the Warner & Swasey turret lathe, telescopes, binoculars and other products exhibited at the recent Cleveland Industrial Exposition.

Gisholt Machine Co., Madison, Wis. Leaflet for loose leaf binder illustrating operations of finishing street-car motor pinions on the Gisholt 24-inch big bore turret lathe with 5-inch spindle hole.

Joseph Dixon Crucible Co., Jersey City, N. J. Booklet on care of belting, containing illustrations showing methods of lacing belts and giving practical pointers on general care of belts and application.

Richard Dudgeon, Broome & Columbia Sts., New York. Catalogue No. 6 of hydraulic jacks and power pumps made in a great variety of styles and sizes for all classes of service.

Cincinnati Iron & Steel Co., Cincinnati, Ohio. General catalogue of shears, punches, hoists, travelers, etc., for structural, boiler, machine, wagon, blacksmith, sheet, metal, and other shops.

Richard W. Jefferis Co. Camden, N. J. Folder illustrating Jefferis pressed steel lockers for use in armories, gymnasiums, factories, clubs, stores, offices, schools, shops, etc.

Hess-Bright Mfg. Co., Philadelphia, Pa. Catalogue of propeller thrust, ball bearing blocks for marine engines and other service requiring efficient thrust bearings.

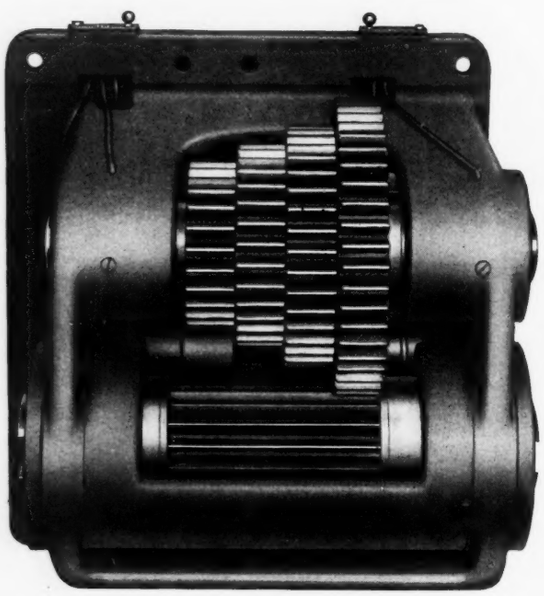
Cincinnati-Bickford Tool Co., Cincinnati, Ohio. Folder describing the Cincinnati 24-inch high-speed shaft-driven drilling and tapping machine with motor and gear box drive.

Consolidated Safety Valve Co., 85-89 Liberty St., New York. Reprint of paper by Philip G. Darling on safety valve capacity read before the American Society of Mechanical Engineers, February 23, 1909.

Electric Welding Products Co., Cleveland, Ohio. Booklet illustrating finished steel bolts and screws having the heads electrically

Severe Service Demands Substantial Construction

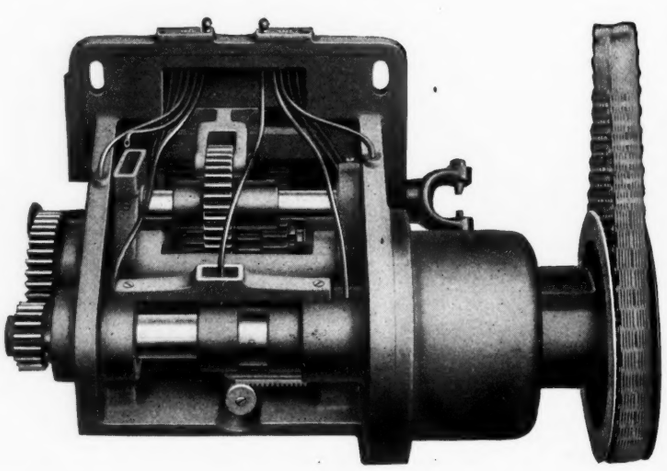
That is why so much care is given to the design and construction of each part of B. & S. Milling Machines.



THE accompanying cuts show excellent examples of the strong and rigid constructions employed in the **spindle speed** and **feed cases** of the

B. & S. Constant Speed Drive Milling Machines

NOTE the rigid mounting of change gears and the compact and heavy proportions of supporting parts—All shafts are of steel, hardened and ground and run in bronze bearings—All gears are of hardened machinery steel and have long pointed teeth to afford instant engagement without employment of any auxiliary mechanism—The holes in all gears are ground concentric with the pitch circle after hardening; silent running is thus assured—The simplicity of the oiling arrangement is plainly apparent in both cuts.

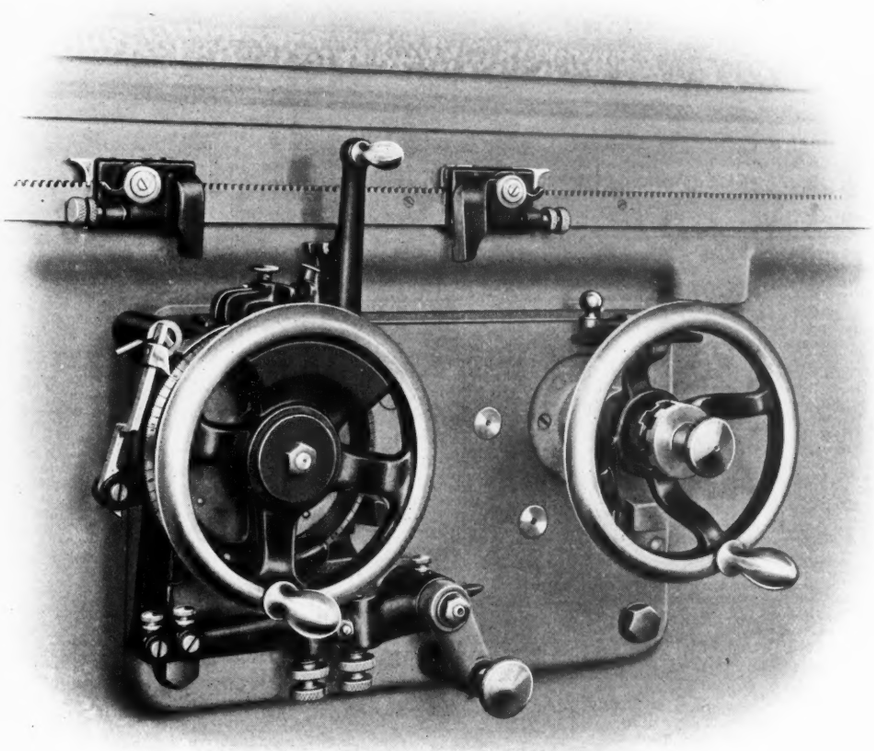


Brown & Sharpe Mfg. Co.

PROVIDENCE, R. I., U. S. A.

Uniform Feeding Lengthens Life of Grinding Wheels

The attainment of a uniform movement of the wheel slide is one of the prominent features of the



Automatic Cross Feed

on B. & S. Grinding Machines.

OTHER IMPORTANT POINTS

The extremely delicate adjustment of wheel slide made possible by this mechanism—Adjusting screws for varying feed at each end of stroke; allowing a coarser feed at one end than at the other, in cases where it is desired—The ability to move table beyond reversing points without disturbing adjustment of reversing dogs—Adjusting screws for fine adjustment of reversing dogs—Simplicity of construction and economy of operation.

Brown & Sharpe Mfg. Co.

PROVIDENCE, R. I., U. S. A.

welded to the bolts. The booklet lists hexagon head cap screws, hexagon head coupling bolts, etc.

BUFFALO FORGE CO., Buffalo, N. Y. Bulletin 78C on high efficiency of blowers for forges and fires, and catalogue DW on a new design of exhaust fan of the disk type, illustrating pulley and direct-connected types. Tables are contained giving speeds, capacity and prices.

WARREN WEBSTER & CO., Camden, N. J. General catalogue of Webster specialties, Part VIII, describing system of steam circulation, vacuum governors, vacuum controllers, damper regulators, feed water heaters and purifiers, heater connections, boiler feeders, etc.

WHITMAN & BARNES MFG. CO., Catalogue No. 72 of Whitman & Barnes high-speed drills, comprising "Diamond" high-speed twist drills and reamers; "Norka" high-speed drills; "Hercules" high-speed twist drill chucks, sleeves, sockets, etc.; "Economy" high-speed twist drills.

CRESCENT MACHINE CO., Leetonia, Ohio. Catalogue of wood-working machinery comprising band saws, single spindle shapers, double spindle shapers, saw tables, jointers, wood workers, planers, surfacers, planers and matchers, disk grinders, universal borers, etc.

STERLING WHEELBARROW CO., Milwaukee, Wis. Price list of ribbed channel steel foundry flasks with malleable iron pin holders and cold rolled machine steel pins. The combination is unbreakable and very rigid, making a flask that is practically indestructible.

BUCKEYE JACK MFG. CO., Louisville, Ohio. Catalogue of Buckeye jacks for car shops, car repair men, garages, automobile users and for other users requiring powerful lifting and lowering jacks for any purpose.

WILLIAM SELLERS & CO., Inc., Philadelphia, Pa. Part catalogue No. 440 on a wheel turning lathe for car wheels. This lathe has turret tool heads and a powerful drive. On test made May 15 it turned four pairs of steel-tired wheels in an average time of less than twenty minutes each. See description in another part of this number.

WESTERN ELECTRIC CO., 463 West St., New York. Bulletin containing reprint of article published in *Power*, June 1907, entitled "First Rateau Generator Installed in America." The article illustrates and describes this generator which was installed in the plant of the International Harvester Co. at Chicago.

UNIVERSAL DRAFTING MACHINE CO., Cleveland, Ohio. Catalogue of "Universal" drafting machines of plain bearing and ball bearing types. The catalogue also lists the "Junior" drafting machine made on the same general principle as the larger apparatus, but of cheaper construction so as to be within the reach of students and others who have comparatively small use for drafting tools.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4669 on Curtis steam turbines for low pressure and mixed pressures. The bulletin contains curves showing results of tests of an engine in combination with a low-pressure Curtis turbine, and a chart showing the power used and the costs, which indicate the increased capacity and economy secured by installing low-pressure turbine sets.

JOSEPH T. RYERSON & SON, Chicago, Ill. Bulletin No. 49, illustrating and describing the Ryerson internal combustion riveter which requires no power plant as is the case with compressed air, hydraulic and steam installations. The power for riveting is supplied by the explosion of a mixture of air and gas in the work cylinder, and the action is under perfect control of the operator.

WESTERN ELECTRIC CO., 463 West St., New York. Pamphlet entitled "An International Achievement," being a description of the rapid replacement of the Gutenberg telephone exchange at Paris, France, which was wrecked by fire September 20, 1908. A 10,000-line switchboard was built in the Hawthorne plant near Chicago and installed in the Paris exchange and turned over to the French officials November 30, just sixty days after the contract was awarded.

MILWAUKEE LOCOMOTIVE MFG. CO., Milwaukee, Wis. Pamphlet illustrating gasoline driven locomotives for service in manufacturing plants, mills, lumber yards, mines, plantations, quarries, tunnels and for general transportation service. The locomotive is built on the general lines of the first electric locomotives, having the operator's cab in the center where he has an unobstructed outlook in both directions. These locomotives are operated by one man, and are under perfect control.

LEES-BRADNER CO., Cleveland, Ohio. Folder illustrating the Lees-Bradner gear generator for hobbing spur, spiral and worm gears, and threading worms. This machine will automatically hob spur or spiral gears from 0 to 14 inches outside diameter of any circular pitch up to 4 inches diametral pitch, in steel. Worm gears can be automatically cut up to 1 inch circular pitch and 14 inches outside diameter, with a hob of any size up to 5¾ inches outside diameter.

MURCHEY MACHINE & TOOL CO., Detroit, Mich. Catalogue of automatic collapsing taps, automatic opening dies, automatic double head nipple machines, semi-automatic double head nipple and pipe threading machines, roller pipe cutting-off machines, tapping machines, improved three-jaw quick-acting tapping chucks, indexed ball bearing, revolving fitting, and valve chuck, grinders for cutter wheels and pipe dies, multiple-head push nipple lathes, double spindle tapping attachments, etc.

READING IRON CO., Reading, Pa. Pamphlet illustrating the relative durability of wrought iron pipe and steel pipe. The consensus of opinion of many experts and users is that wrought-iron pipe is far more durable than steel pipe. In the oil regions where it is common practice to pull the casing of abandoned wells, wrought iron pipes after several years of service are found practically as good as new, whereas steel pipe is generally so badly deteriorated as to be hardly worth pulling out of the ground.

BULLARD MACHINE TOOL CO., Bridgeport, Conn. Catalogue of the Bullard vertical turret lathe which is designed as a general machine tool having incorporated the valuable characteristics of the lathe and boring mill. A demonstration of this machine made at the June conventions of the American Railway Master Mechanics' and Master Car Builders' associations showed remarkable adaptability to locomotive work. The machine has adjustable rails, micrometer dials, observation stops, constant drive, centralized control, quick-acting brake, direct reading feeds, power rapid traverse, two universal independent turret heads, etc. The gears are encased and work in flood lubrication.

ACHESON OILDAG CO., Niagara Falls, N. Y. Booklet containing reports of Professor Charles F. Mabery and committees of the Automobile Club of America, on the merits of oildag as a lubricant. Oildag is deflocculated graphite, which has the valuable property of remaining in suspension in oil, and not settling to the bottom, the great fault of the ordinary graphite. The value of graphite as a lubricant is generally conceded, but the difficulty of feeding it to the bearings has interfered seriously with its use in the piston. The deflocculated graphite meets this serious objection and promises to make graphite a universal lubricant for gas engines, steam engines, and all classes of service.

W. B. MCALLISTER CO., Cleveland, Ohio. Booklet on the Cleveland Industrial Exposition, illustrating and describing the construction of the temporary exposition building which was erected by the W. B. McAllister Co. The problem was peculiar and difficult, and was solved in an ingenious and interesting manner. A temporary structure was required 155 feet wide and 318 feet long, without many posts or supports to obstruct the view. It was constructed with wooden walls covered with staff and with a fire-proof and water-proof canvas roof supported by three large masts 12 x 12 inches. From each of the mast foundations also sprung four booms or struts which supported the canvas between the center and the side walls. The construction was found eminently satisfactory and even ornamental in appearance. The bases were converted into handsome drinking fountains, thus giving the base construction an air of distinct utility for other than the purpose for which it really was designed.

MANUFACTURERS NOTES

UNION TWIST DRILL CO. has appointed Mr. E. W. McKeen, for many years connected with its mechanical department, manager of the New York store at 54 Warren St., New York.

PARKER WHITE METAL & MACHINE CO., 10th and Wayne Sts., Erie, Pa., is successor to Berry & Parker, manufacturers of die castings. The business will be continued as before.

MACDONALD & MACDONALD, 50 Church St., New York, have taken into the concern Mr. Richard Cavanagh, and the firm name will be hereafter Macdonald, Macdonald & Cavanagh.

HARRISBURG FOUNDRY & MACHINE WORKS, Harrisburg, Pa., has appointed Mr. F. W. Jackson district manager for the Baltimore district, with headquarters at 1415 Continental Trust Building.

STOEVER FOUNDRY & MFG. CO., Myerstown, Pa., with sales office at 140 Cedar St., report the sale of twelve of its No. 12, type 8 cutting-off machines, motor-driven, capacity 4 to 12 inches, to Spang-Chalfant & Co., Pittsburg, Pa., for the equipment of its new mill.

NEWALL ENGINEERING CO. (proprietors, Peter Hooker, Ltd.), London, manufacturers of measuring machinery, limiting gages, micrometers, surface plates, etc., has removed its works and office to Blackhorse Lane, Walthamstow, London, where a new factory has been completed.

FRANK B. GILBRETH CO., New York, has moved to new and larger quarters at 60 Broadway, New York, where one-half of a floor in the Knickerbocker Trust Company's new building, corner of Broadway, Exchange Place and New Street has been taken.

SMURR & KAMEN, 101 South Clinton St., Chicago, Ill., manufacturers of turret lathes, drill presses and wire crimping machines, have broken ground for a new factory, 41 by 100 feet, at Sacramento St. and Carrol Ave. The company expects to occupy the new factory about August 1.

C. J. VAN DOREN CO., 5 West Madison St., Chicago, Ill. Circulars descriptive of the Van Doren lubricator for line-shafts, jack-shafts, engine bearings, and similar situations. The lubricator embodies a principle which is said to be economical of lubricant, while insuring perfect lubrication at all times.

BILGRAM MACHINE WORKS, 1221-35 Spring Garden St., Philadelphia, Pa., is the successor of Hugo Bilgram. Mr. Bilgram has disposed of his business to the corporation formed under the laws of the state of Pennsylvania. Mr. Bilgram is president of the new concern; Max Uhlmann, vice-president; J. Roland Parker, secretary, and Bertha Bilgram, treasurer.

A. O. WALWORTH & CO., Chicago, Ill., dealers in new and second-hand machine tools, have opened a store at 101 South Clinton St., where they will have large show-rooms and a machine shop in the basement for the rebuilding of second-hand machine tools. The company is desirous of obtaining the agencies for various lines of machine tools, and will manufacture a number of specialties later on.

E. S. JACKMAN & CO., Chicago, Ill., agents for the Firth-Sterling Steel Co., one year ago took D. E. Jackman, brother of E. S. Jackman, into the firm, and finding this policy of expansion beneficial, has now taken D. G. Clark into partnership. Mr. Clark has made a favorable reputation as an up-to-date tool steel man, and is widely known for his work and study in connection with the tempering of "Blue Chip" steel by the barium chloride and gas furnace methods.

WESTERN ELECTRIC CO., 463 West St., New York, reports that returns for May show that the business for the company is running at the rate of $46,000,000 to $48,000,000 per annum. The May sales were 70 per cent greater than the corresponding month in the preceding year. The report that the General Electric Co. had completed arrangements to take over the heavy electrical manufacturing branch of the Western Electric Co., at Hawthorne, Ill., is denied.

QUINCY, MANCHESTER, SARGENT CO., Plainfield, N. J., has changed its corporate name to the Q. M. S. Co., in order to simplify matters of correspondence, telephoning, etc. The change has been under consideration for some time, many friends and customers practically demanding it, as the great objection to the old name was the inconvenience and time consumed in pronouncing the name over the telephone, etc.

CURTIS & CURTIS CO., 8 Garden St., Bridgeport, Conn. Catalogue of pipe cutting and threading machinery for hand and power, built under the Forbes patents. The dies are mounted in a revolving head with means for adjustment to compensate for wear. The head is provided with a cut-off attachment which is automatically fed into the pipe. The machines are built in a variety of styles suitable for all classes of work and have a capacity ranging up to 10-inch pipe.

FOOS GAS ENGINE CO., Springfield, Ohio, reports that its business during May was larger by considerable than that of the same month of any previous year. The month of April shows the largest business ever done by the company in a single month, and the first five months of the present year produced greater business than has ever come to the company in the same time. The plant is the largest exclusively devoted to gas engine manufacture, and is being run to its full capacity fourteen hours per day.

LINCOLN MOTOR WORKS CO., Cleveland, Ohio, has changed its corporate name to the Reliance Engineering Co. The management remains the same and the company will continue to manufacture the Lincoln variable speed motors and a complete line of constant speed motors. The company furthermore is specializing in machine shop practice and is equipped for designing and manufacturing all mechanical details and driving mechanism necessary in applying motor drive to any class of machinery.

WESTINGHOUSE MACHINE CO., Pittsburg, Pa., recently made a contract with the Potlatch Lumber Co., Potlatch, Idaho, for a 600-kilowatt Westinghouse steam exhaust turbine to be installed in the Potlatch Lumber Co.'s plant. The low-pressure turbine will take steam at about 15 pounds absolute pressure from a Corliss engine and a high-speed triple engine. The capacity of the plant will be greatly increased with practically no cost except the charges for the low-pressure turbine installation.

AMERICAN LOCOMOTIVE CO., 111 Broadway, New York, has presented the department of railway engineering of the University of Illinois a full size locomotive front end mounted for inspection and study. The model represents a two-cylinder compound, and includes a pair of full size cylinders and intercepting valve in section. The apparatus is so arranged that students can clearly see the path of the steam from the boiler to the cylinder and the action of the intercepting valve when the locomotive is changed from simple to compound and *vice versa*.

MACBETH IRON CO., Cleveland, Ohio, engineers, founders and machinists, builders of blowing engines, etc., and the Bruce-Meriam-Abbott Co., of Cleveland, builders of gas engines, were consolidated June 1, the name of the new company being the Bruce-Macbeth Engine Co. Both companies have been long established in Cleveland, and the amalgamation makes one of the largest and strongest concerns of its kind. The officers of the company are W. C. Bruce, president; C. W. Kelly, vice-president; C. J. Snow, secretary and treasurer; C. E. Curtiss, manager. The officers with A. D. Macbeth, J. B. Meriam, and F. B. Abbott constitute the board of directors.